FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION

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BY

DR. TUSHAR KANT SINGLA

SUPERVISOR

DR. HARPAL SINGH SELHI

DEPARTMENT OF ORTHOPAEDICS
DAYANAND MEDICAL COLLEGE AND HOSPITAL
LUDHIANA
(MAY 2021)

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I declare that the thesis entitled **"FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION"** has been prepared by me under the guidance of **Dr. Harpal Singh Selhi,** Professor, Department of Orthopaedics, Dayanand Medical College and Hospital, Ludhiana. No part of this thesis has formed the basis for the award of any degree previously.

_____

Dr. Tushar Kant Singla
Department of Orthopedics
Dayanand Medical College & Hospital
Ludhiana-141001 Punjab

Date:

CERTIFICATE

I certify that **Dr. Tushar Kant Singla** has prepared his thesis entitled **"FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION"** for the award of degree of M.S. in Orthopaedics of Baba Farid University of Health Sciences, under my guidance. He has carried out the work at the Department of Orthopaedics, Dayanand Medical College & Hospital, Ludhiana.

Supervisor

Dr. Harpal Singh Selhi
Professor
Department of Orthopedics
DMC&H, Ludhiana

Co-Supervisor

Dr. Deepak Jain
Professor
Department of Orthopedics
DMC&H, Ludhiana

Date:

ENDORSEMENT BY THE HEAD OF THE DEPARTMENT AND PRINCIPAL

This is to certify that the thesis entitled **"FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION"** is a bonafide research work done by **Dr. Tushar Kant Singla** under the guidance of **Dr. Harpal Singh Selhi**, Professor, Department of Orthopedics, Dayanand Medical College & Hospital, Ludhiana.

Head of Department

Dr. Rajnish Garg
Professor & Head
Department of Orthopedics
DMC&H, Ludhiana

Principal

Dr. Sandeep Puri
Principal
DMC&H, Ludhiana

Date:

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Dr. Tushar Kant Singla
Department of Orthopedics
Dayanand Medical College & Hospital
Ludhiana

Date:

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Dedicated To My Parents

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Dr. Tushar Kant Singla

ABBREVIATIONS

AVN	Avascular necrosis
AO/OTA	Orthopaedic trauma association
AKI	Acute kidney injury
CT	Computed tomography
DF	Domestic fall
DM-2	Type II Diabetes Mellitus
K-Wire	Kirschner wire
RTA	Road traffic accident
CAD	Coronary artery disease
PTCA	Percutaneous transluminal coronary angioplasty
ORIF	Open reduction and internal fixation

ABSTRACT

Introduction - Proximal humerus fractures are quite prevalent in both elderly and young patients. These fractures can be managed with a variety of treatment options ranging from conservative management to arthroplasty. Due to frequent injury to blood supply of humeral head and various other anatomic considerations, no treatment modality gives good results in all patients. This study aims to evaluate union time, functional outcome and complications of Closed Reduction and K-wire fixation of proximal humerus fractures.

Material and Methods - From November 2018 to December 2019, 18 patients of proximal humerus fracture treated with Closed Reduction and K-wire fixation in our hospital were included in this study and were prospectively followed up for a period of 6 months. Functional outcome was measured with Constant Murley score.

Results - Out of 18, 15 patients were available for follow up and final analysis. 8 patients had 3 part, 2 patients had 2 part and 5 patients had 4 part fractures as per Neer's Classification. According to AO/OTA classification, 12 patients had Type B fracture, 2 had Type A fracture and only 1 patient had Type C fracture. Average age of the group was 60 years with an average time to union of 6.4 weeks. 11 out of 15 patients had good to excellent results according to Constant Murley score with an average score of 65.53. Most common complication was loosening of K-wires.

Conclusions - Closed reduction and K-wire fixation of proximal humerus fracture has satisfactory results with good functional outcome in majority of patients. It has several advantages over open methods of fixation especially in elderly patients as it is less invasive and biological environment of the fracture is maintained. Loosening or migration of K-wires is a common complication and can lead to secondary loss of reduction and subsequent malunion or non-union. We conclude that Closed Reduction and K-wire fixation is a good alternative to open methods of fixation in treatment of 2 part, 3 part fractures and in certain 4 part fractures.

Keywords - proximal humerus fractures, closed reduction, percuatenous pinning, K-wire fixation

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INTRODUCTION

The fractures of proximal humerus are defined as fractures occurring at or proximal to the surgical neck of humerus. These account for almost 4%-5% of all fractures and 45% of all humeral fractures.[1,2] It is the third most common fracture in patients above the age of 65 years, after the fractures of Hip and distal Radius.[3]

These fractures have a dual age of distribution, occurring either in young patients, following high-energy trauma or in patients older than 50 years of age, due to low -energy injuries.[4] The majority of proximal humerus fractures in older, osteoporotic adults are due to a direct blow to the lateral aspect of the shoulder, although these can be sustained by a fall on outstretched hand.[5]

Seventy-five percent of the patients are over 60 years of age. Frequent falls and weakened bone secondary to osteoporosis may predispose these patients to proximal humeral trauma. The overall female to male ratio has been reported to be 3:1 but may reach 7:1 in ageing population.[6] According to current projections, every 20th woman at 65 years of age will sustain a fracture of the proximal humerus in her remaining life time. [7]

A recent trend analysis from Switzerland showed that, between 2000 and 2007, the absolute number of proximal humeral fractures increased by 22.8% in women and 35.5% in men.[8,9] A 3-fold increase in osteoporosis related fractures is expected in the year 2030.[10] The ageing population is also staying much more active into their later days, requiring us to no longer accept the results of older treatment methods that result in lower functional outcomes.[11]

Proximal humerus fractures often occur in the fit and independent elderly patients who are still a net contributor to the society but who might well be converted to a degree of social dependency by the fracture.[12]

The fracture of proximal humerus might result in up to four major fracture fragments - humeral head, greater tuberosity, lesser tuberosity and humeral shaft just proximal to the insertion of Pectoralis Major

tendon.[13] The proximal humerus can fracture as a result of 3 main loading modes:

- compressive loading of glenoid onto the humeral head - in patients with normal bone, humeral epiphysis resists this and the energy is transferred distally to weaker metaphysial bone leading to surgical neck fracture, whereas in osteoporotic bone epiphysis also fractures, leading to complex multi-fragmentary fractures
- bending forces at surgical neck
- tension forces of rotator cuff at greater and lesser tuberosities - causes displacement of greater tuberosity postero-medially and lesser tuberosity medially

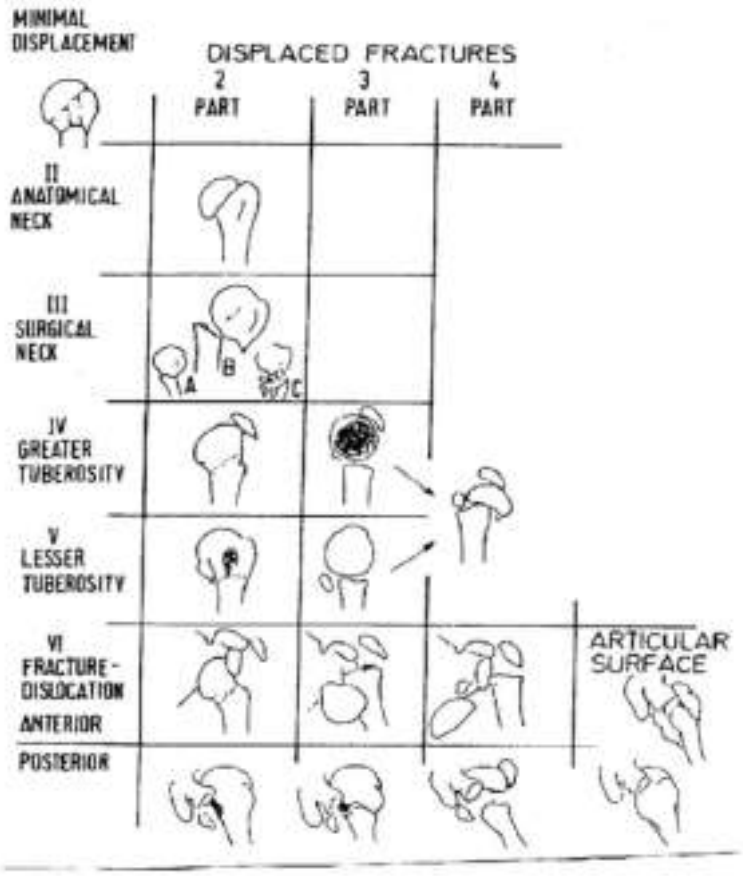
Disruption of normal anatomical relationship between the four parts of proximal humerus as well as incongruity of joint can result in decrease in range of motion and strength of shoulder.[14] Tuberosity fractures in association with a fracture of the surgical neck of the humerus are important as they may result in rotational deformity of the humeral head. If the lesser tuberosity is fractured the stabilising effect of Subscapularis is lost resulting in external rotation of humeral head with subsequent malunion and impaired gleno-humeral function. A fracture of the greater tuberosity will lead to internal rotation of the head due to unopposed action of subscapularis. Soft tissue scarring and tears of tendons of rotator cuff also contribute to stiffness and loss of movement.

Proximal humerus fractures can be classified according to 2 classification systems.

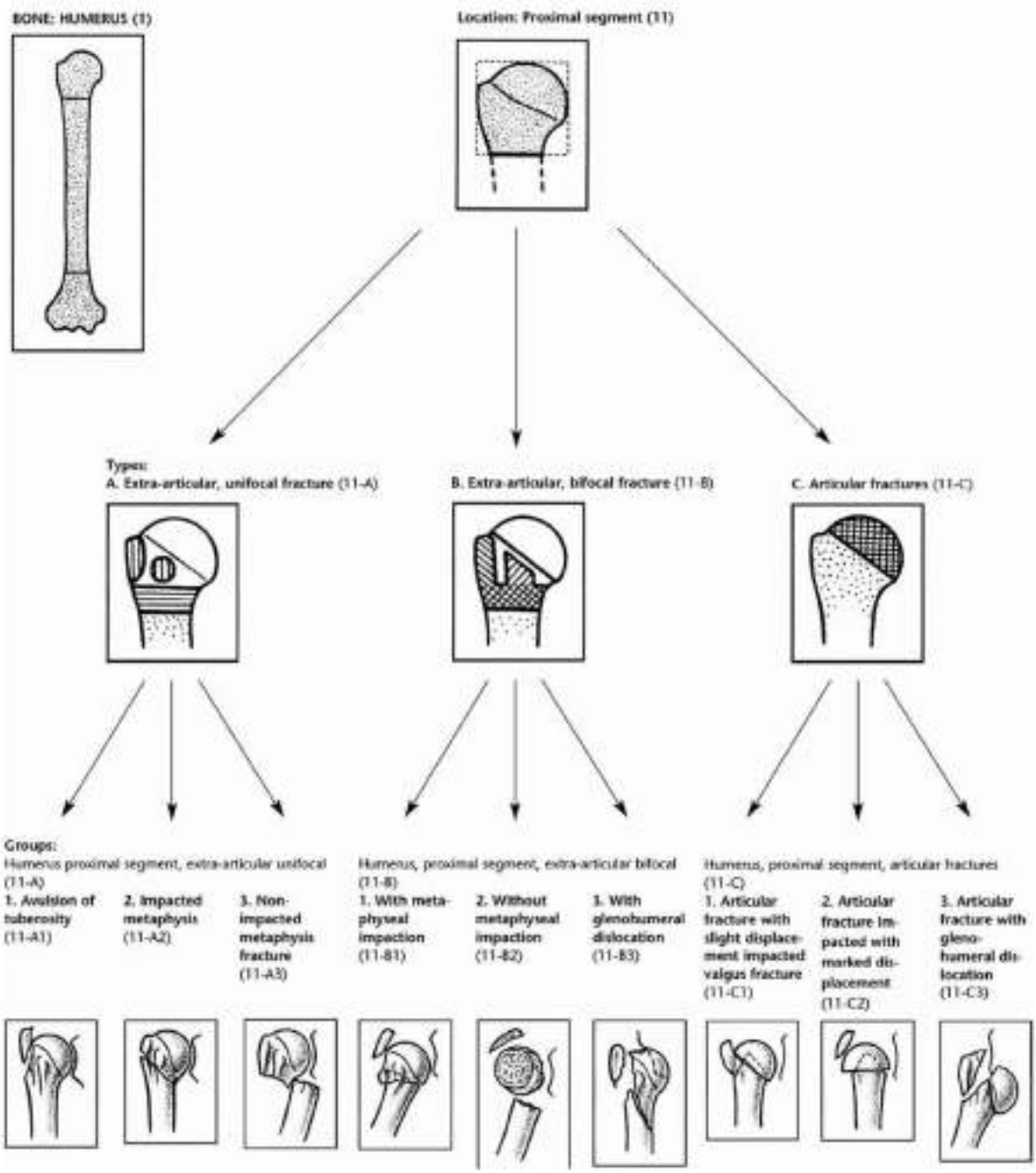
Neer's classification, introduced in 1970, divides proximal humerus fractures according to 4 fracture segments and their displacement, of at least 1 cm, and/or angulations, of at least 45 degrees.[15]

- 1 part fractures, undisplaced fractures, include fractures with less than 1 cm displacement and less than 45 degrees of angulation
- 2 part fractures, consist of displaced fractures with 2 fracture segments. These include 2 part lesser tuberosity, 2 part greater tuberosity, 2 part surgical neck and 2 part anatomical neck fractures

- 3 part fractures, consist of displaced fractures with 3 fracture segments. These invariably include surgical neck fracture and concomitant fracture of either greater or lesser tuberosity.
- 4 part fracture, exhibit displacement of all four fracture segments
- Fracture dislocations, further can be classified as true fracture dislocations and fractures involving articular surface.



Picture 1 - Neer's classification system[15]


BONE: HUMERUS (1)
Location: Proximal segment (11)
Types:
A. Extra-articular, unifocal fracture (11-A)
B. Extra-articular, bifocal fracture (11-B)
C. Articular fractures (11-C)
Groups:
Humerus proximal segment, extra-articular unifocal (11-A)
1. Avulsion of tuberosity (11-A1)
2. Impacted metaphysis (11-A2)
3. Non-impacted metaphysis fracture (11-A3)
Humerus, proximal segment, extra-articular bifocal (11-B)
1. With metaphyseal impaction (11-B1)
2. Without metaphyseal impaction (11-B2)
3. With glenohumeral dislocation (11-B3)
Humerus, proximal segment, articular fractures (11-C)
1. Articular fracture with slight displacement impacted valgus fracture (11-C1)
2. Articular fracture impacted with marked displacement (11-C2)
3. Articular fracture with glenohumeral dislocation (11-C3)

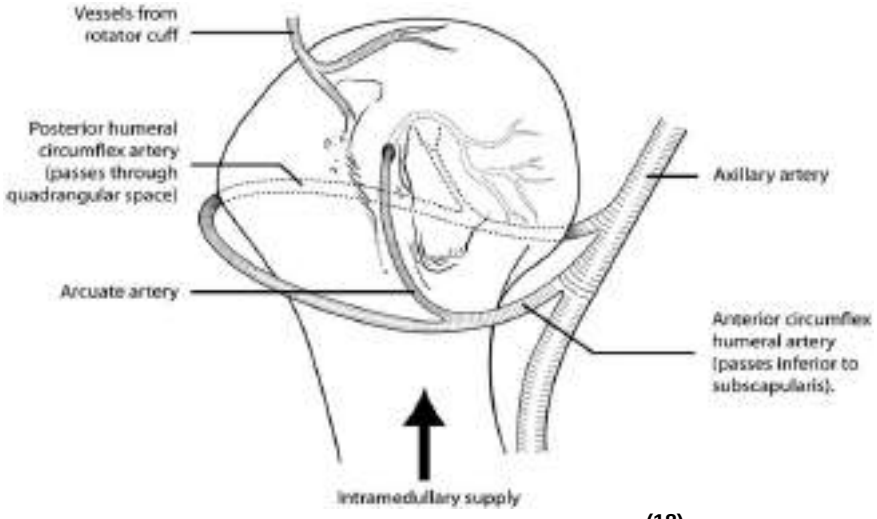
Picture 2 - AO/OTA classification [(16)]

AO/OTA classification is based on fracture location and the presence of impaction, angulation, translation or comminution of the fracture, as well as whether a dislocation is present. Proximal humerus is the 11 bone segments, 1 for humerus and 1 for proximal segment.[(16)]

- Type A fractures, extra-articular unifocal fractures associated with single fracture line. Further grouped into 3 subclasses.

- Type B fractures, extra-articular bifocal fractures associated with two fracture lines. Further subclassified into 3 subclasses.
- Type C fractures, articular fractures involving humeral head or anatomical neck. Further grouped into 3 subclasses.

Vascularity around proximal humerus is also of great importance. Ascending branch of anterior humeral circumflex artery course immediately lateral to the bicipital groove and is of paramount importance in maintaining vascularity of the articular segment. Due to injury of blood supply of the articular segment with certain configurations, there is increased risk of osteonecrosis of humeral head in the long term. Cadaveric perfusion studies of common fracture patterns of humeral head suggest that the postero-medial vessels may maintain the arterial supply to the humeral head when other vascular supply has been abolished as a result of a fracture.[17] This vessel may get injured when there is fracture of humerus at anatomical neck and excessive soft tissue striping may further damage the residual blood supply to head and increases the chance to osteonecrosis. Axillary artery may be damaged in fracture surgical neck of humerus as sharp edges of distal fragment are pulled medially by strong Pectoralis Major. Axillary nerve is at risk in fracture and fracture dislocations as it courses through the quadrilateral space.


Vessels from rotator cuff
Posterior humeral circumflex artery (passes through quadrangular space)
Arcuate artery
Axillary artery
Anterior circumflex humeral artery (passes inferior to subscapularis).
Intramedullary supply

Picture 3 - Blood supply of proximal humerus [18]

Approximately 85% of fractures of the proximal part of the humerus are minimally displaced (a so-called one-fragment fracture), and assumed to heal well with non-operative treatment.[19]

Approximately 10-20% of all proximal humerus fractures with higher degrees of displacement, especially ones with more than two fragments require reduction and fixation, with goals to achieve primary fracture stability and to allow for early mobilization of the shoulder. Fixation of these fractures and achievement of good functional outcome with fixation remains challenging, especially in case of comminution of the metaphyseal zone and/or for patients with severe osteoporosis.[20] Osteoporosis is not only the cause for higher bone fragility, but it also negatively influences the anchorage of implants. Fracture patterns in osteoporotic bone which has been compared with an empty egg shell include metaphyseal comminution, impaction of fragments, comminution of tuberosities and inferior subluxation of head. Although excessive comminution can occur in young patients with normal bone density due to high energy trauma.[21]

Accurate imaging of fracture fragments and the degree of displacement is only possible with good radiology. At the very minimum, two good quality views must be obtained, an AP and an axial lateral. A third view, the lateral scapular, gives additional information.[22] A computed tomography (CT) is recommended for complex fracture situations as radiographs may not demonstrate well the fracture fragments due to limited ability to position the patient or superimposition of fracture fragments. CT scan is a better modality to demonstrate both the displacement and rotation of fracture fragments and the integrity of the articular surface of the humeral head.[23] Coronal reconstruction images give more detail about the alignment of the humeral head and allow assessment of comminution at the level of the humeral calcar, the integrity of the inferomedial hinge, and extent of metaphyseal fracture extension. Sagittal reconstructions help in determining the flexion or extension deformity of the proximal humerus with regard to the shaft. Furthermore, in this plane fatty atrophy of the rotator cuff muscles may

be analysed using soft tissue window, ruling out preinjury rotator cuff pathology.[22]

Most proximal humerus fractures are minimally displaced and can be treated nonoperatively. Recent literature suggests that among patients with displaced proximal humeral fractures involving the surgical neck, there was no significant difference between surgical treatment compared with nonsurgical treatment.[24] A short period of immobilization followed by early motion yields predictably high union rates and good outcomes.[25]

Unless medical contraindications exist, operative management is recommended for displaced proximal humerus fractures, because closed treatment of these fractures generally leads to poor results.[26] Malunions in conservatively treated patients lead to loss of shoulder function especially in fractures associated with displacements of greater tuberosity resulting in subacromial impingement, tears of rotator cuff and changes in the biomechanics of the muscles around the shoulder joint in the long term.[27] Therefore the treatment of displaced three and four-part fractures is an unsolved dilemma.

The need for anatomical fixation and early mobilisation of the shoulder with proximal humeral fracture is required to achieve maximum range of movement and to reduce handicap associated with dysfunctional shoulder especially in young patients.[28,29,30,31] However severe comminution in elderly osteoporotic patients render anatomical reduction difficult as well as prone to loss of fixation due to poor bone quality.

Various methods of fixation have been described in literature, each one have their own distinct advantages and disadvantages. The treatment of displaced humeral fractures especially in elderly patients with osteoporotic bone disease represents a complex and challenging problem, with no consensus on absolute best treatment protocol for fracture in this region.

Open reduction and internal fixation (ORIF) offers the advantages of allowing direct fragment manipulation and visualization of reduction and implant position. However, surgical dissection may jeopardize

fracture biology thereby potentially interfering with healing and increasing the risk of AVN of the humeral head.[32]

Two most commonly used methods of ORIF include tension band wiring and plate and screw fixation.

Satisfactory healing rates and functional outcomes have been reported with conventional plate and screw fixation, especially in younger patient populations.[33] High rates of complications also have been reported including infection, humeral head necrosis, and subacromial impingement.[34] There are higher chances of postoperative displacement and varus collapse, especially in elderly patients and three- and four-part fractures. [35] Locking plate fixation allows for better angular stability and significantly stronger and more resilient construct.[36] Precontroured plates allow insertion of locking screws in different sectors of the humeral head which is helpful in adequate fixation of majority of fragments. There is decreased incidence of varus collapse and hardware loosening with locking screws, but the incidence of screw penetration and cutout have increased.[37]

Tension band wiring neutralizes the deforming forces generated by the rotator cuff at the level of the tuberosities, and bending at the level of the surgical neck. Due to the load-sharing properties of this fixation, compression is generated between fragments during motion, thereby promoting healing and allowing early rehabilitation.[38] Wire or suture fixation through the entheses of the rotator cuff has the advantage of not relying on weak osteoporotic bone but on stronger tendinous tissue for fixation.[39] Another advantage is the requirement of minimal hardware thus reducing the risk of implant related subacromial impingement. It has the disadvantage of the other methods requiring opening of fracture site. Other reported complications of this method include painful steel wire, AVN of the humeral head, infection, and transient axillary neurapraxia.

Intramedullary (IM) fixation is another attractive alternative for the treatment of proximal humeral fractures due to the theoretical biomechanical advantages in osteoporotic bone and minimal surgical invasion.[40] Historically several IM devices including Enders nails have

been used with limited stability.[41,42] Modern nailing systems use 8-12 mm hollow locking nails inserted in an antegrate manner. IM nailing is particularly useful in two-part surgical neck fractures, with diaphyseal extension and pathologic fractures.[43] This method is relatively contraindicated in the presence of preoperative nerve palsy due to risk of catastrophic neurologic injury during reaming and nail placement in case of entrapped nerve in fracture site. The main complication is damage to rotator cuff at entry point and subsequent symptoms like chronic shoulder pain [44] Another frequent complication is backing out of the proximal screws. Other complications include glenohumeral screw protrusion, AVN of the humeral head, nonunion, malunion, and tuberosity displacement.

Hemiarthroplasty, or humeral head replacement, is indicated in highly comminuted head-splitting fractures and head depression fractures involving more than 40% of the articular surface or when there is likely compromise of vascularity of head as predicted by Hertel's criteria.[45] The main challenge associated with hemiarthroplasty is the unpredictability of outcomes ranging from near normal to just adequate pain control with only fair function. Several factors play a key role in achieving optimal results. Adequate reduction and fixation of the tuberositiesis is the most important factor in determining long term outcomes. Shoulder hemiarthroplasty requires accurate reconstruction of the proximal humerus for the rotator cuff to stabilize and power the shoulder for adequate function. Poor function after primary hemiarthroplasty is often related to complications related to the tuberosities.[46] Glenoid erosion may lead to delayed shoulder pain and occurs due to increased stresses may occur between the prosthetic head and glenoid surface. Other complications include subacromial impingement, non-union and malunion of tuberosities, infection and heterotrophic ossification.[47]

Closed reduction and percutaneous K-wire fixation of proximal humerus fractures has a theoretical advantage of less damage to soft tissues and vascularity of humeral head. The biological environment of fracture fragments is maintained thus increasing chances of union.

Surgical morbidity is less which is advantageous in patients with multiple comorbid conditions. Although this method of fixation can be complicated by loosening, septic or aseptic, and migration of wires thus causing loss of reduction, more so in osteoporotic bones. Secondary loss of reduction can cause malunion or non-union and subsequently requires another procedure to achieve fixation. Despite the simplicity of the treatment method requiring minimal apparatus, it requires considerable technical knowledge about the fracture fragments and experience in closed anatomical reduction of the fracture.

The range of therapeutic options is wide and subject to controversy. This study is planned to evaluate the outcome of proximal humerus fractures managed with K-wire fixation of Proximal Humerus fractures.

AIMS AND OBJECTIVES

To analyse union time, complications and study the functional outcome of proximal humerus fractures managed with Closed Reduction and K-wire fixation.

Jaberg et al [48] followed up 48 patients who had had closed reduction and percutaneous pinning of an unstable fracture of the proximal end of the humerus for an average of three years (range, two to seven years) after the operation. According to the point-scale of Saillant et al., the result was good or excellent in 34 patients, fair in 10, and poor in 4. Four patients had loss of fixation and had repeat fixation with percutaneous pinning after a second closed reduction. Only one of them had a poor result because of malunion. Four patients had a superficial pin-track infection and loosening of pins, one patient had a deep infection, and two had a non-union. Complete avascular necrosis with collapse of the humeral head developed in only two patients. It was concluded that although closed reduction and percutaneous pinning is a technically demanding procedure, results were comparable with or superior to other previously described operative methods for the treatment of unstable fractures of the proximal end of the humerus.

Resch et al [49] studied 27 patients, 9 with 3-part and 18 with 4-part fractures, treated by percutaneous reduction and screw fixation. Thirteen of the 4-part fractures were of the valgus type and five showed significant shift. Instruments were introduced into the fracture through small incisions to manoeuvre fracture fragments under the control of an image intensifier. The average follow-up was 24 months (18 to 47). All the 3-part fractures showed good to very good functional results, with an average Constant score of 91% (84% to 100%), and no signs of avascular necrosis. Good radiological results were achieved in 4-part fractures when impacted in valgus except for one patient with partial avascular necrosis of the head. In those with lateral displacement of the head, revision to a prosthesis was required in one patient because of avascular necrosis and in another because of secondary redisplacement of the fracture. Avascular necrosis was seen in 11% of 4-part fractures. The average Constant score in patients with 4-part fractures who did not need further operation was 87% (75% to 100%).

Soete et al [50] treated 31 patients with displaced fractures of proximal humerus treated by transitory percutaneous pinning. According to Neer's classification; there were 7 two-part, 20 three-part, and 4 four-part fractures. The Constant score was used for evaluation of the results; the mean score was 80 points. Due to high mean age of the patients (68 years) the scores were diminished as 25 points are attributed to the strength. Avascular necrosis was observed in 5 cases: 2 three-part and 3 four-part fractures. It was concluded that transitory percutaneous pinning is a good technique for the management of displaced 3-part fractures of the proximal humerus even in the older population, as the shoulder will tolerate a moderate residual deformity without changing the functional outcome significantly. Transitory percutaneous pinning, on the other hand, is not a satisfactory method for the management of 4-part fractures.

Resch et al [51]studied a total of 88 patients with 37 B1 and B2 fractures and 41 C1 and C2 fractures of proximal humerus that were operated percutaneously from 1990 to 1999. The initial 27 patients with 9 B1 and B2 and 18 C1 and C2 fractures were followed up. All B1 and B2 fractures showed good to very good functional results (Constant Score 91%). The Constant Score of the C1 and C2 fractures was 87%. The necrosis rate of the C1 and C2 fractures was 11%. It was concluded that the presence of soft tissue bridging of the various fragments is crucial for the reduction to gain benefit from the ligamentotaxis effect. Thus, fractures such as valgus impacted or three-part fractures are very good indications for this technique. They also stated that the necrosis rate is low or at least not increased compared to cases treated by open reduction and there is reduced risk of adhesions within the surrounding gliding surfaces since the fracture is not exposed, and the rehabilitation period is shorter. According the observations made by them, besides extraarticular fractures, surgical neck fractures with avulsion of the greater tuberosity (B1 and B2 fractures) and valgus impacted fractures (C1 and C2 fractures) are good indications for this method as intact connections to rotator cuff tendons or remnants of intact periosteum between fragments still exist.

Less good indications are the fractures with severe lateral displacement of the articular segment and severely displaced fracture dislocations (C2 and C3 fractures).

Fenichel et al [52]retrospectively studied the results of closed reduction and percutaneous pinning using threaded pins for fractures of the humeral head in patients with two- and three part fractures of the proximal humerus according to Neer's classification. Fifty patients (32 females and 18 males) with an average age of 50 years were clinically evaluated after an average follow up of 2.5 years after this procedure (range 1–4 years). The Constant score was used to evaluate the clinical outcome. Out of 50 patients, 18 (36%) obtained excellent results, 17 (34%) good results, eight (16%) fair results and seven (14%) achieved only poor results. The average Constant score was 81 (range 60–100). Fractures confined to the surgical or anatomical neck generally did better than those associated with a greater tuberosity fragment (average score 86 versus 78). Patients who required shaft stabilisation and in addition to reduction and fixation of the greater tuberosity showed a lower average score (68). There were no cases of avascular necrosis, neurovascular complications or deep infections. A significant loss of fracture position due to failure of internal fixation occurred in seven cases, out of which three underwent revision surgery. Authors concluded that closed reduction and percutaneous pinning offers a good fracture position and stability with minimal soft tissue damage for displaced two- and three- part fractures of the humeral head but requires close monitoring for four weeks, to watch for any secondary displacement or failure of fixation.

Calvo et al [53] evaluated 74 patients with displaced proximal humeral fractures (mean age, 70.9 years) treated with closed reduction and percutaneous pinning. Fractures were classified radiographically following Neer's system, and the quality of reduction was assessed according to Kristiansen and Kofoed. Patients were also evaluated clinically with the Constant scale. Overall, the reduction was good in 72% of fractures, but the probability of obtaining a satisfactory reduction of displaced tuberosities was significantly lower in

comparison to the humeral head. Four-part fractures obtained the worst radiographic results. The mean Constant scores were 65.8 +/- 18 points for the injured shoulder and 79.5 +/- 9.1 points for the opposite shoulder. Clinical results correlated with the quality of reduction. The final conclusion of the study was that closed reduction and percutaneous pinning should be reserved for 2-part fractures, and can also be used in 3-part fractures in elderly patients, in whom an incomplete reduction can yield satisfactory clinical results.

Keener et al [54] studied the outcome of displaced proximal humeral fractures after closed or percutaneous reduction with percutaneous fixation. They studied 35 patients of which, 27 were followed up for a minimum of 1 year after surgery. There were seven 2-part, eight 3-part, and twelve valgus-impacted 4-part proximal humeral fractures. All fractures were reduced and stabilized with percutaneous techniques only. The mean duration of follow-up was 35 months. All fractures healed after the index procedure. The mean pain score on a visual analog scale was 1.4. The mean American Shoulder and Elbow Surgeons and Constant scores were 83.4 and 73.9, respectively. Four patients healed with malunion, and in four, glenohumeral joint osteoarthritis developed. Fracture type, age, malunion, or osteoarthritis had no significance influence on measured outcomes. Authors concluded that the percutaneous treatment of selected proximal humeral fractures results in predictable union and good clinical results with a low rate of complications.

Aschauer et al [55] studied reduction and fixation of displaced fractures of the humeral head by percutaneous methods in simple subcapital fractures of the humerus, (AO - 11A2, A3) and multifragmentary fractures of the proximal humerus, (AO - 11B1, B2, C1, (C2)) in 200 patients (78 men, 122 women) that were followed up at least 2 years (24-81 months) postoperatively. The head fragment, generally impacted in valgus, was reduced by means of an elevator inserted percutaneously and fixed to the shaft with two crossed K-wires. The K-wires were fixed to the lateral cortex of the humerus with a locking device attached by one screw to prevent slippage. Displaced tubercles

were also reduced percutaneously by the aid of small bone hooks and were stabilized with cannulated screws. They found that the average Constant Score for four-part fractures was 87%. 24% of the patients had to be operated on a second time (shortening of the wires or reosteosyntheses). In 8.5% of patients secondary change of management was necessary. In 3% of patients clinically relevant avascular head necrosis occurred, and pseudarthrosis in 3%.

Bogner et al [56] studied 76 patients aged over 70 years with three- or four-part fractures treated by percutaneous reduction and internal fixation using the Humerusblock. Of the patients 50 (51 fractures) were available for follow-up after a mean of 33.8 months (5.8 to 81). The absolute, age-related and side-related Constant scores were recorded. Of the 51 fractures, 46 (90.2%) healed primarily. Re-displacement of fragments or migration of K-wires was seen in 5 cases. Necrosis of the humeral head developed in 4 patients. In 3 patients a secondary arthroplasty had to be performed, in 2 because of re-displacement and in 1 for necrosis of the head. The mean Constant score of the patients with a three-part fracture was 61.2 points (35 to 87) which was 84.9% of the score for the non-injured arm. In four-part fractures it was 49.5 points (18 to 87) or 68.5% of the score for the non-injured arm. The study concluded that Humerusblock technique can provide a comfortable and mobile shoulder in elderly patients and is a satisfactory alternative to replacement and traditional techniques of internal fixation.

Bahrs et al [57] conducted a retrospective study to evaluate displaced proximal humeral fractures treated with percutaneous methods and to detect factors predicting functional outcome. After a median follow-up period of 79.7 months, 105 patients with 9 A-fractures, 36 B fractures and 60 C-fractures as per AO/OTA classification (nine two-part-fractures, 41three-part fractures and 55 four-part fractures) were assessed. Functional outcome was measured based on the Constant and UCLA scores. Of all patients, 70–75% had excellent or good Constant and UCLA scores. In 74% a good or satisfactory quality of initial reduction fracture was achieved. About one-fifth (21%) of the

fractures showed a secondary displacement. Twenty-seven percent of the patients had signs of humeral head necrosis and 22% had implant related problems. There were significant correlations between a high final score and young age, low AO fracture severity, good quality of fracture reduction and residual osseous deformity, absence of secondary fracture displacement, implant-related complications, shoulder arthrosis and humeral head necrosis at the time of follow-up. In conclusion, the non-plate head-preserving fixation of proximal humeral fractures is an alternative treatment for displaced proximal humeral fractures.

Blonna et al [58] retrospectively studied the outcome of K-wire osteosynthesis of a varus displaced proximal humeral fracture in patients over 65 years old, compared to a control group treated nonoperatively, using the Constant score (CS), modified Constant score (MCS), and the QuickDASH score. The patients were followed-up for 12 months. It was concluded that K-wire osteosynthesis of varus displaced proximal humerus fractures yielded good results that are superior to those treated nonoperatively.

Blonna et al [59] compared percutaneous pin fixation with hybrid technique (HT), using osteosutures and an external fixator. 51 patients were treated with percutaneous fixation using 2.5-mm terminally threaded pins and 55 patients were treated with the Hybrid technique. In both groups, an open reduction and osteosutures augmented with percutaneous fixation was used when closed reduction was insufficient to provide anatomical reduction. The patients were assessed at 6- and 12-month follows-ups using DASH score, Constant score, and Modified Constant score (MCS). Sixteen patients treated with traditional pins experienced complications compared to 6 patients in the HT group. Pins migration affected 8 patients in the traditional pins group and 1 case in the hybrid group. The MCS at the 12-month follow-up was 89 in the HT group and 77 in the traditional pins group. It was concluded that the Hybrid Technique is a valuable option for the treatment of proximal humeral fractures with potential benefits.

El-alfy et al [60] studied 18 patients with displaced proximal humeral fractures were treated by closed reduction and percutaneous fixation with present K-wires inserted in a palm tree construct. The age of the patients ranged from 38 to 75 years with an average of 56 years. The fractures were two-part in 13 cases and three-part fractures in five cases. The average time of healing was seven weeks. The follow-up period ranged from 14 months to 39 months. The Constant score ranged from 45 to 88 with a mean of 73. The results were satisfactory in 77% and unsatisfactory in 23% of the cases. The complications included pin tract infection in 2 cases, intra-articular wire migration in 1 case, skin necrosis around the wires in 3 cases and malunion with varus deformity in 1 case. It was concluded that palm tree technique of pin fixation produces satisfactory outcomes with good hold of reduction and allows for early joint movements.

Eid et al [61] studied the role of closed reduction and percutaneous pinning using K-wires and Schanz screws in two-part proximal humeral fractures in providing enough stability to allow early mobilization until healing occurs in elderly patients. The procedure was performed on 33 patients with proximal humerus fractures. Twenty-seven patients were available for the final follow-up. Of those 27 patients, 17 had two-part surgical neck fractures; while 10 had three-part fractures. Two 3.0 mm Schanz screws were used for fixation in patients with two-part fractures plus one additional Schanz screw or K wire in the 10 patients with three-part fractures. The mean Constant score modified according to the age and sex was 89.8% (range: 77.3-97.2%). Fifteen patients had excellent results, 11 patients had good results, and one patient had a fair result. It was concluded that closed reduction and percutaneous pinning using Schanz screws is a useful and effective technique and provides enough stability to allow an early rehabilitation program till union occurs in elderly patients.

Rowles et al [62] studied percutaneous pinning in cadaveric shoulders with the intact proximal part of the humerus under fluoroscopic guidance. A total of five 2.5-mm terminally threaded AO pins, including two lateral, one anterior, and two greater tuberosity pins, were inserted

in each shoulder. The specimens were then dissected to determine the distance of each pin from adjacent neurovascular structures as well as key anatomic relationships. The proximal lateral pins were located at a mean distance of 3 mm from the anterior branch of the axillary nerve. Four of the twenty lateral pins were noted to penetrate the articular cartilage of the humeral head. The anterior pins were located at a mean distance of 2 mm from the tendon of the long head of the biceps (perforating the tendon in three specimens) and of 11 mm from the cephalic vein (perforating the vein in one specimen). The proximal tuberosity pins were located at a mean distance of 6 and 7 mm from the axillary nerve and the posterior humeral circumflex artery (tenting the structures in two specimens with internal rotation), respectively. These pins moved away from the nerve with external rotation of the humerus. This study concluded that this technique may be associated with a risk of injury to important anatomic structures about the shoulder. Lateral pins should be distal enough to avoid injury to the anterior branch of the axillary nerve, and multiple fluoroscopic views should be obtained to avoid penetration of the humeral head cartilage. There may be a risk of injury to the cephalic vein, the biceps tendon, and the musculocutaneous nerve with use of anterior pins, and these pins should be employed with caution. Greater tuberosity pins should be placed with the arm in external rotation, should be aimed for a point 20 mm from the inferior aspect of the humeral head, and should not overpenetrate the cortex.

Carbone et al [63]evaluated the results of percutaneous fixation of three- or four-part fractures of the proximal humerus of patients. A total of 31 patients treated with Minimally Invasive Reduction Osteosynthesis System (MIROS) and 27 undergoing traditional percutaneous pinning were studied. Follow-up evaluations were carried out at three, six, 12 and 16 weeks, and six months, one year and two years postoperatively, using the Constant Score (CS) and subjective shoulder value (SSV) methods. Of the 58 patients, 52 who were available for follow up showed that in both three- or four-part fractures there were significantly higher CS and SSV scores in the MIROS

compared to the TPP group at all the late follow-ups. Lower rates of deep infection, pin tract infection and pin mobilisation were found in the MIROS group ($p < 0.001$). In both groups there was a significant association between the final result (CS) and either the type of fracture or complications ($p < 0.001$).The study concluded that MIROS resulted in better clinical results and less complications than TPP in elderly patients.

Rangan et al [64] studied the clinical effectiveness of surgical vs nonsurgical treatment for adults with displaced fractures of the proximal humerus involving the surgical neck as a part of the Proximal Fracture of the Humerus Evaluation by Randomization (PROFHER) multicenter, parallel-group, randomised clinical trial. 231 patients aged 16 years or older (mean age, 66 years) who presented at the orthopaedic departments of 32 UK National Health Service hospitals, within 3 weeks after sustaining a displaced fracture of the proximal humerus involving the surgical neck, were recruited and followed up for 2 years. 114 patients were managed with surgical intervention while 117 patients were managed with non-surgical intervention with sling immobilisation. They found that there was no significant difference in the Oxford Shoulder Score averaged over 2 years (39.07 points for the surgical group vs 38.32 points for the nonsurgical group) or at individual time points between the two groups. There was no significant difference in the mean SF-12 physical component score, the mean SF-12 mental component score and complications related to surgery or shoulder fracture between the two groups. Equal number of patients required secondary surgery of the shoulder in both the groups. They concluded that there was no significant difference between surgical treatment compared with nonsurgical treatment in patients with displaced proximal humeral fractures involving the surgical neck.

MATERIAL AND METHODS

This study was a prospective study of patients with proximal humerus fractures treated with Closed Reduction and percutaneous K-wire fixation. The patients operated at Dayanand Medical College & Hospital, Ludhiana from 1st November, 2018 to 31st December, 2019 were included in this study. The performa was filled at the time of admission with demographic data and details of injuries recorded.

Inclusion criteria:

1. Closed Proximal Humerus fractures

Exclusion criteria:

1. Fracture dislocation of Head of Humerus
2. Humeral Head splitting fracture
3. Infection at the site of fracture
4. Patients below 18 years of age
5. Pathological fractures
6. Fractures dislocations more than 4 weeks old

Patient coming to Emergency were evaluated for any life threatening injury and general condition of the patient was assessed and affected limb was splinted after detailed examination of the affected limb. All routine investigations were sent as per protocol. Appropriate radiographs were taken to assess the fracture. Classification of fracture was done using Neer's classification system and AO/OTA classification system. Patients was taken up for orthopaedic surgery after obtaining pre-anaesthetic clearance.

Surgical Technique - Patient was positioned on radiolucent OT table in supine or 'beach chair' or semi beach chair position depending upon the surgeon preference with a pack holding the shoulder and thorax about 30-40 degrees off the table. Required parts were painted and draped as per antiseptic protocol. Adequate visualisation of the fracture was done under fluoroscopy. Major anatomical landmarks around shoulder were surface marked on skin to avoid potential injury. Closed reduction of surgical neck fracture component was performed. K-wire(s) were inserted across the fracture site depending on the fracture

anatomy. Reduction and fixation was confirmed by fluoroscopy. K-wires were cut to appropriate length. Skin closure was done. Antiseptic dressing was done.

Follow up was done at 7 or 14 days, then at 1 month, and then every month. Patient was assessed clinically for fracture healing, range of motion, K-wire pin sites and was radiographically checked for the progress of fracture healing. Radiographic union was defined as bridging trabeculations across the fracture site.

Constant and Murley score - This method of shoulder functional assessment combines patient as well as clinician based score.[65] It consists of 100 points allotted to following parameters - Pain (15), Activities of daily living (20), Range of motion (40), and Power (25). Functional assessment was done at 6 weeks, 3 months and 6 months of follow up in prospective patients. The score at 6 months was taken as final functional outcome in all patients. Results were graded as Excellent (score - 80-100), Good (score - 60-79), Fair (score - 40-59) or Poor (score - 0-39).

OBSERVATIONS AND RESULTS

A total of 18 patients of proximal humerus fracture which were treated with closed reduction and percutaneous fixation of the fracture in Department of Orthopaedics, Dayanand Medical College & Hospital, Ludhiana in a period between 1st November, 2018 to 31st December, 2019 were included in the study. Out of these 18 patients, 2 patients expired and 1 patient was lost to follow up and are not included in the final analysis of the study. The following observations were made in preoperative, per-operative and post operative periods.

Table 1 Distribution of patients according to age (n=15)

AGE	No. of cases	Percentage
< 50	3	20.0%
51-60	3	20.0%
61-70	7	46.7%
> 70	2	13.3%
Total	15	100.0%

This table shows distribution of patients in various age groups. Minimum age was 28 years and maximum was 82 years. Mean age in this series was 60 years. Maximum numbers of patients were in the age group of 61-70 years (46.7%). More than 60% of the patients were above the age of 60 years

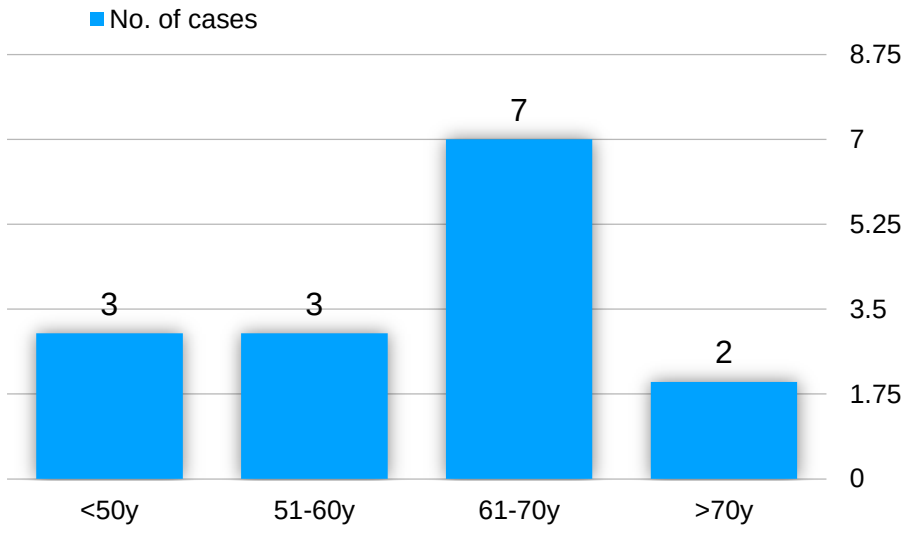


Figure 1 Distribution of patients according to age (n=15)

Table 2 Distribution of patient according to sex

SEX	No. of cases	Percentage
F	9	60.0%
M	6	40.0%
Total	15	100.0%

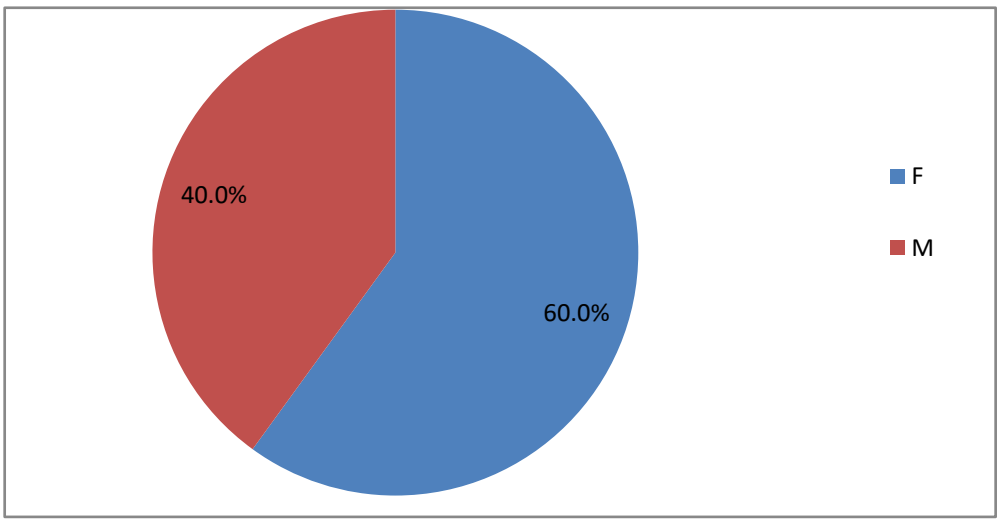


Figure 2 Distribution of patient according to sex

Table 3 Distribution of patients according to mode of injury

MODE OF INJURY	No. of cases	Percentage
Domestic fall	9	60.0%
Road Traffic Accidents	6	40.0%
Total	15	100.0%

This table shows the distribution of patients according to mode of injury. Majority of patients in this series were admitted with history of domestic fall (9 patients, 60%) which includes fall on outstretched hand on a slippery floor or fall from stairs. Rest of the patients were admitted due to Road Traffic Accidents (6 patients, 40%).

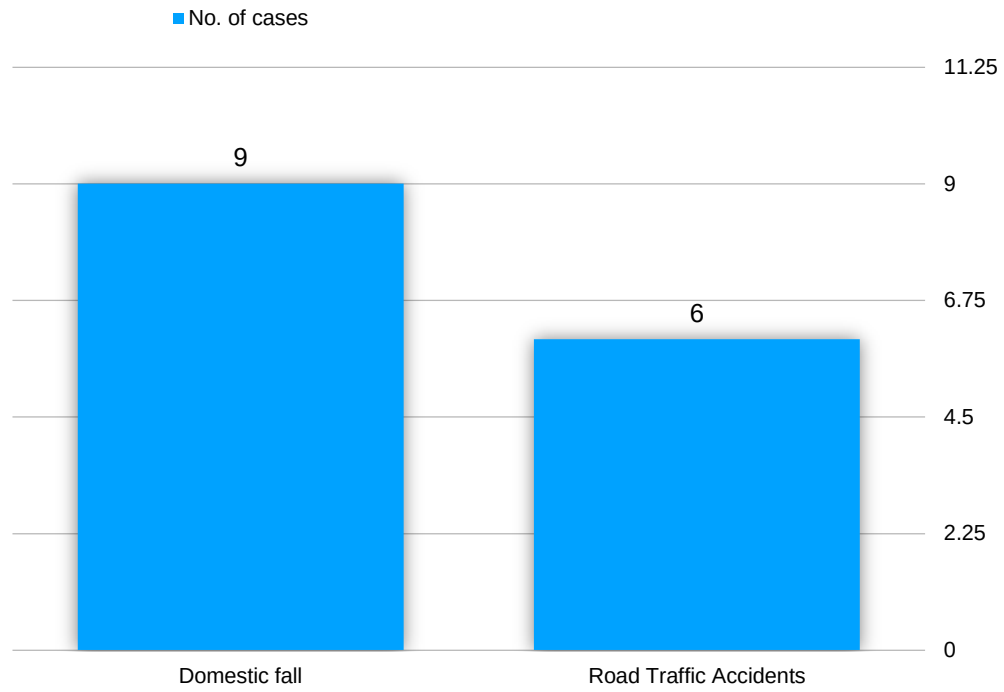


Figure 3 Distribution of patients according to mode of injury

Table 4 Distribution of patients according to age and mode of injury

	<50 years	>50 years
Domestic fall	1	8
Road Traffic Accident	2	4
Total	3	12

Among below 50 years of age group, 2/3rd of the patients presented with road traffic accident. In elderly patients (above 50 years), 2/3rd of the patients presented with a history of domestic fall.

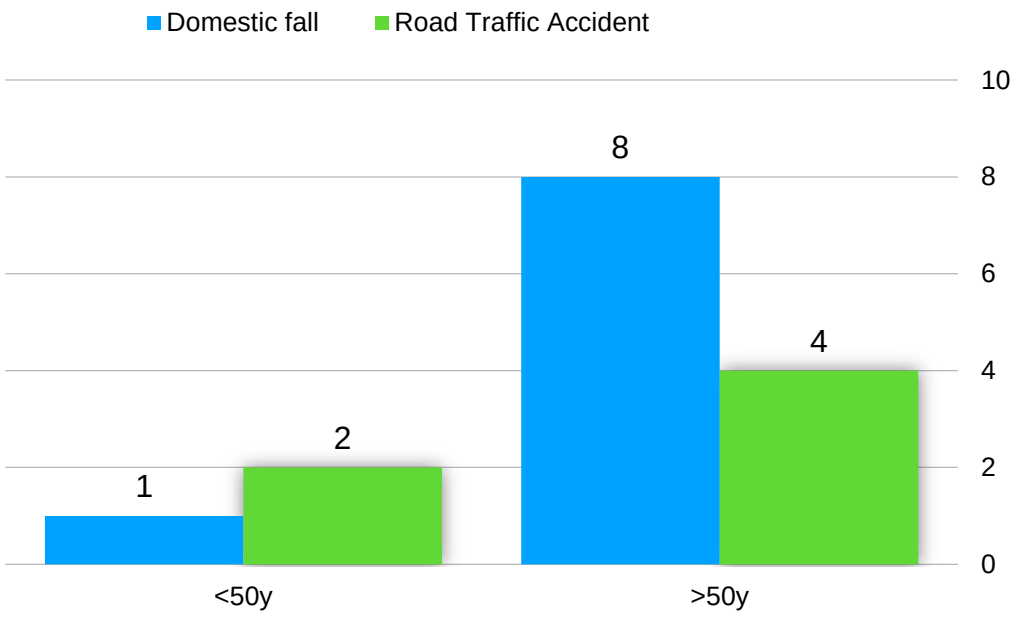


Figure 4 Distribution of patients according to age and mode of injury

Table 5 Distribution of patients according to Associated other injuries

ASSOCIATED OTHER INJURIES	No. of cases	Percentage
Isolated proximal humerus fracture	12	80.0%
Closed fracture intertrochantric femur left	1	6.7%
Closed Fracture Medial malleolus left side	1	6.7%
Closed Fracture Proximal Tibia left side	1	6.7%
Total	15	100.0%

This table shows associated fractures that occurred in various other regions of the body. Majority of the patients (12 patients, 80%) were admitted with isolated fracture of proximal humerus. Only 3 patients (20%) had associated injuries. One patient had closed fracture of Intertrochanteric femur resulting from a domestic fall (low energy trauma) whereas the other two patients had associated injuries of ankle and proximal tibia resulting from Road Traffic Accident (high energy trauma).

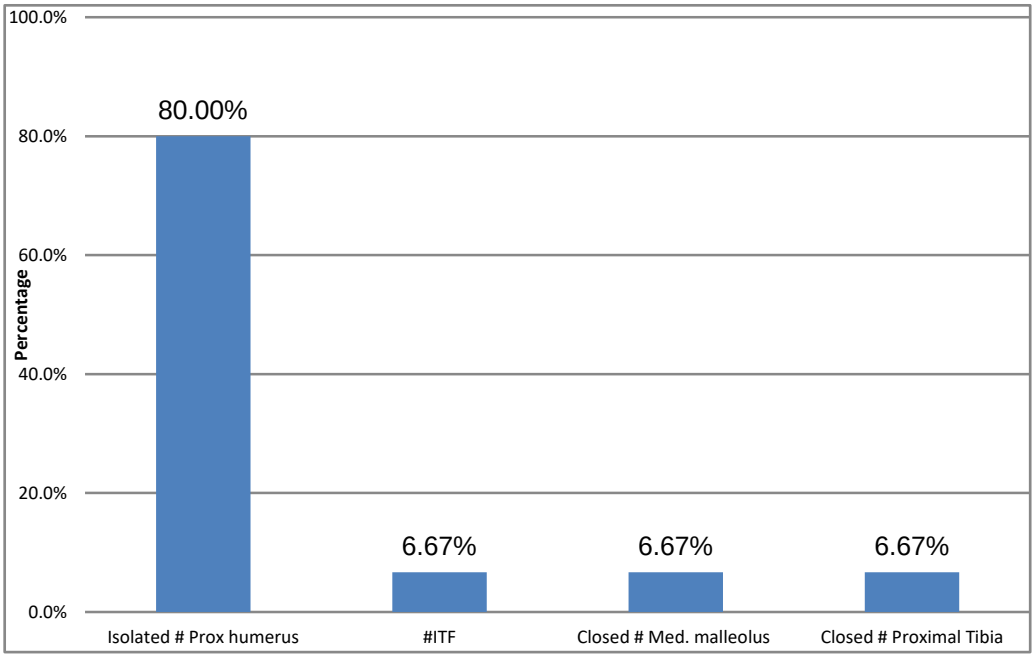


Figure 5 Distribution of patients according to Associated other injuries

Table 6 Distribution of patients according to Associated Comorbidities

ASSOCIATED COMORBIDITIES	No. of cases	Percentage
No comorbidity	7	46.7%
DM-2, AKI, Hypertension	1	6.7%
DM-2, hypertension, CAD - Post PTCA	1	6.7%
DM-2, Hypertension, Obesity	1	6.7%
Hypertension	2	13.3%
Hypertension, hypothyroidism	1	6.7%
Hypothyroidism	1	6.7%
Hypothyroidism, hypertension	1	6.7%
Total	15	100.0%

Less than half of the patients (46.7%) had no comorbidities. Majority of the patients had multiple comorbidities including Type 2 Diabetes mellitus, Hypertension, Coronary Artery Disease, Hypothyroidism etc. making them high risk patients for any type of operative management.

Table 7 Distribution of patients according to Neer's Classification

FRACTURE CLASSIFICATION_ NEER	No. of cases	Percentage
2 part	2	13.3%
3 part	8	53.3%
4 part	5	33.3%
Total	15	100.0%

More than half of the patients were found to have 3 part fracture as per Neer's classification (8 patients).

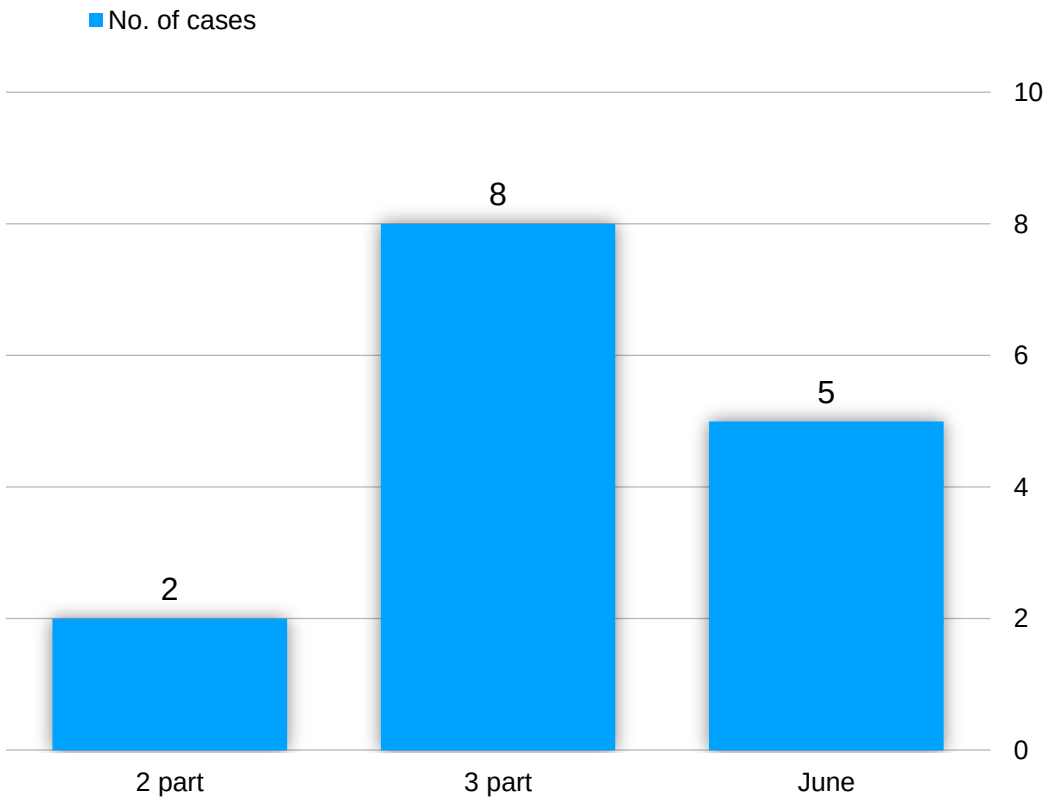


Figure 6 Distribution of patients according to Neer's Classification

Table 8 Distribution of patients according to AO/OTA classification

AO/OTA	No. of cases	Percentage
11-A2	1	6.7%
11-A3	1	6.7%
11-B1	12	80.0%
11-C2	1	6.7%
Total	15	100.0%

This table shows distribution of patients according to AO/OTA classification. Out of various subtypes, 80% of patients were found to have 11-B1 type of fracture which includes extra-articular, bifocal fractures with metaphyseal impaction. Other subtypes have one patient each (6.7% each) including - 11-A2, 11-A3 subtypes which are extra-articular univocal fractures and 11-C2 that are impacted articular fracture with marked displacement.

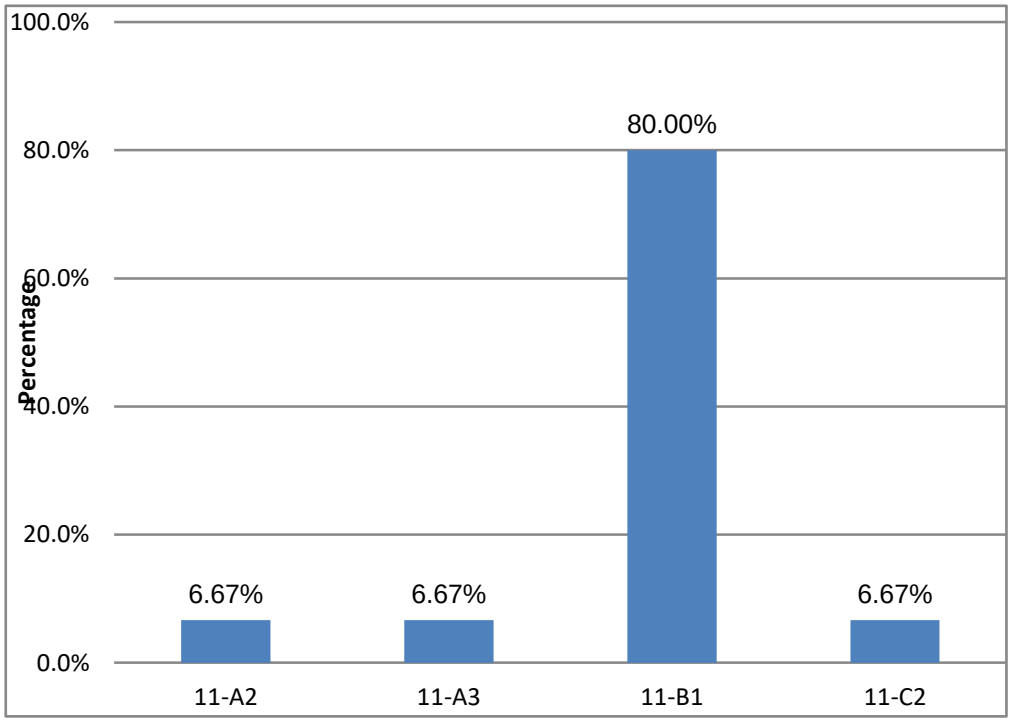


Figure 7 Distribution of patients according to AO/OTA classification

Table 9 Comparison of distribution of cases according to AO/OTA and Neer's Classification

	2 part	3 part	4 part	Total
Type A	2	-	-	2
Type B	-	8	4	12
Type C	-	-	1	1
Total	2	8	5	15

In our study, all Type A fractures were 2 part fractures and all Type C fractures were 4 part fractures. Among the Type B group, 2/3rds of the fractures were 3 part fractures.

Table 10 Distribution of cases on the basis of number of K-wires used

NO. OF K- WIRES USED	No. of cases	Percentage
4	7	46.7%
5	5	33.3%
6	1	6.7%
7	2	13.3%
Total	15	100.0%

Maximum number of patients were managed with just 4 K-wires (7 cases, 46.7%). Average number of K-wires used were 4.87

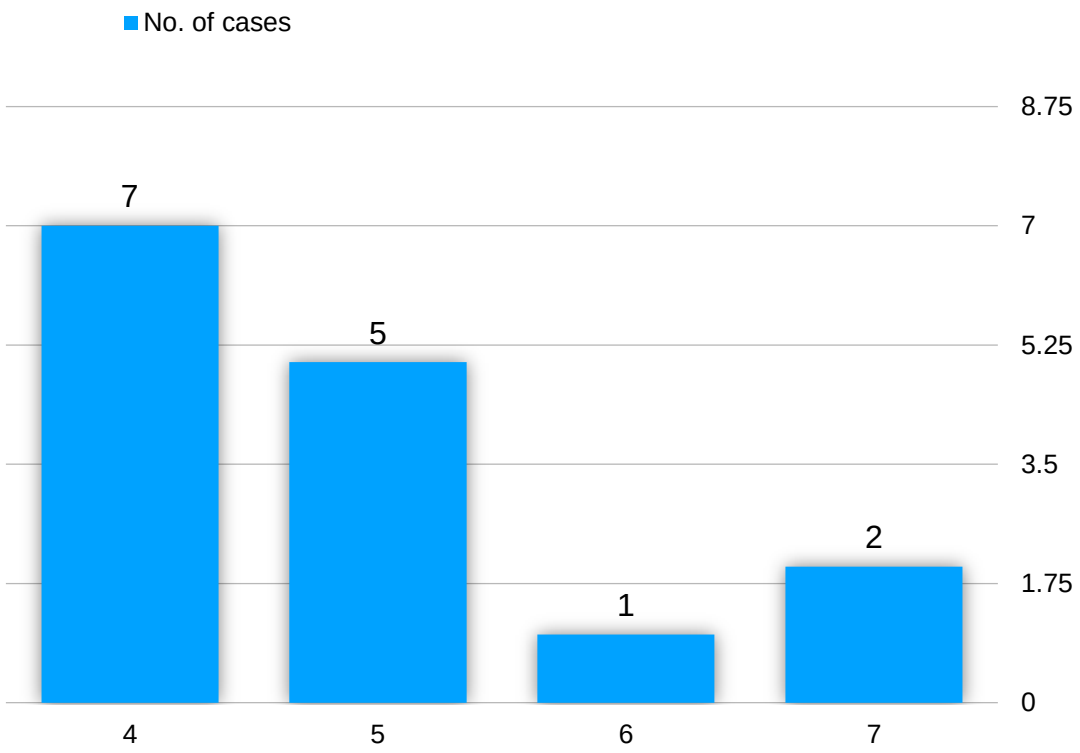


Figure 8 Distribution of cases on the basis of number of K-wires used

Table 11 Average number of K-wires required in different types of fracture as per Neer's classification

FRACTURE CLASSIFICATION_ NEER	Average number of K-wires used
2 part	4.50
3 part	4.77
4 part	4.83

Average number of K -wires required increased with increased severity of fracture as per Neer's Classification

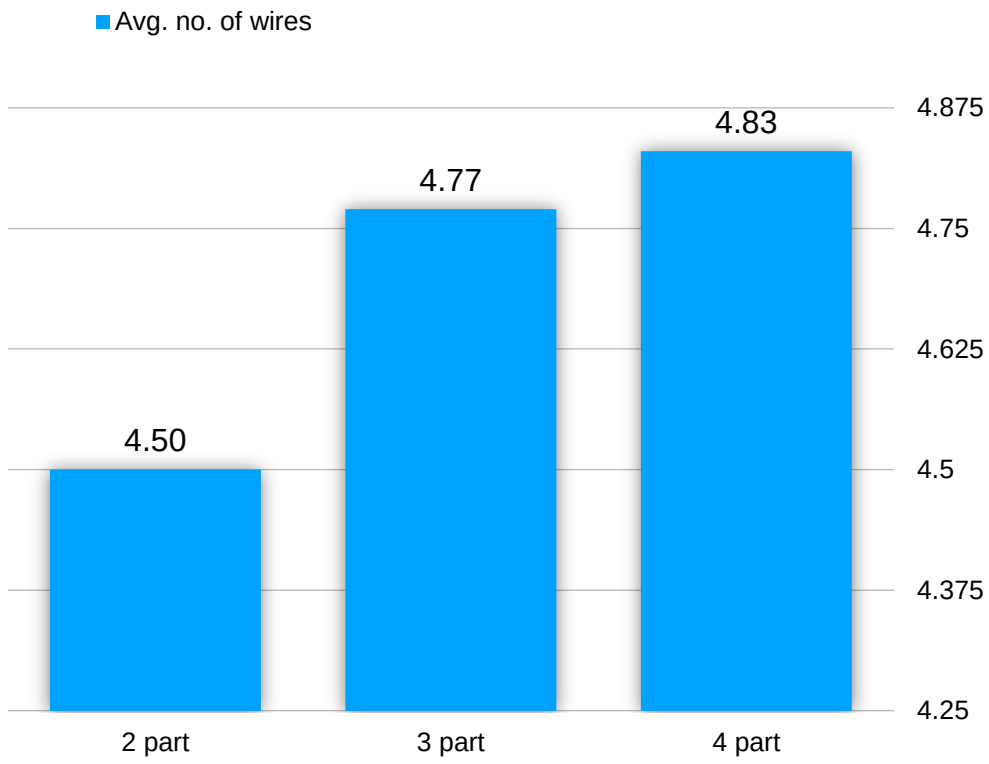


Figure 9 Average number of K-wires required in different types of fracture as per Neer's classification

Table 12 Distribution of patients according to Time period (in weeks) after which K-wires were removed

Time period after which wire removed (weeks.days)	No. of cases	Percentage
No	1	6.7%
< 4 week	1	6.7%
4-8 week	10	66.7%
> 8week	3	20.0%

This table shows the distribution of patients according to time period (weeks) after which K wires were removed. In 2/3rd of patients, K-wires were removed between 4 to 8 weeks after surgery. Average time in weeks for removal of wires in all patients was 6 weeks, with minimum of 3.5 weeks and maximum of 9.2 weeks.

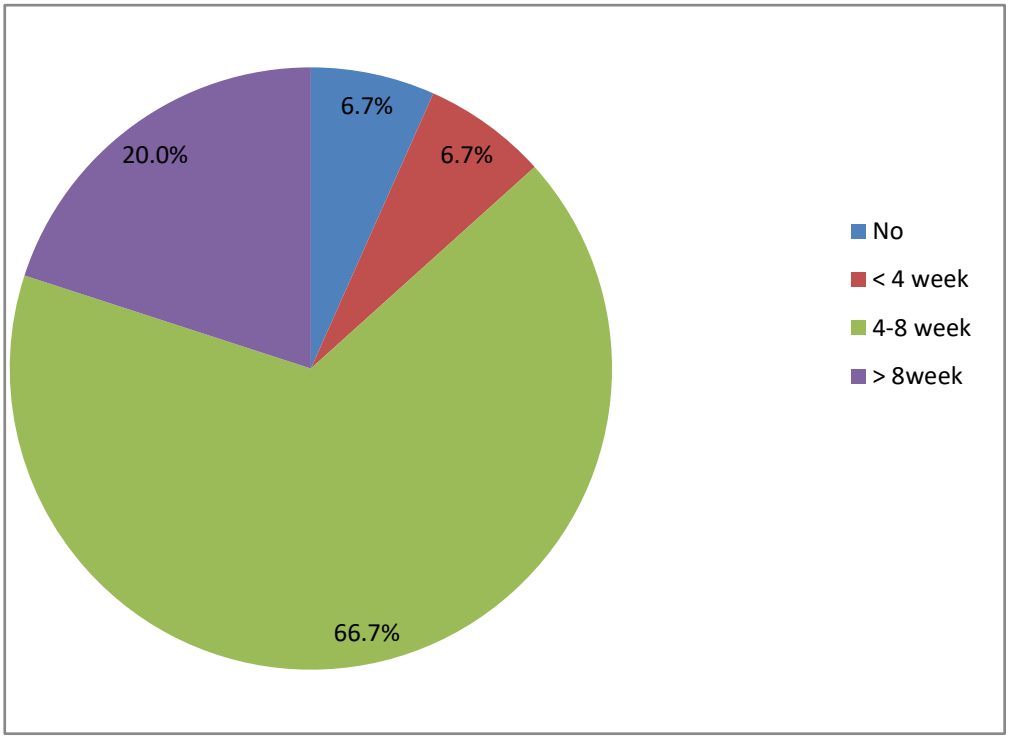


Figure 10 Distribution of patients according to Time period (in weeks) after which K-wires were removed

Table 13 Distribution of patients according to post-operative complications

Post-op Complications	No. of cases
No complication	12
loosening of k-wires	4
Pin site infection	1

This table shows distribution of patients according to the post-operative complications. Majority of the patients experienced no complications in the immediate, early and late post operative periods (12 out of 15 patients). Loosening of K-wires occurred in 3 patients but no incidence of migration of the wires was observed in these patients. Superficial pin site infection occurred in 1 patient and was associated with loosening of K-wires which was managed with oral Antibiotics until the infection healed and fracture united.

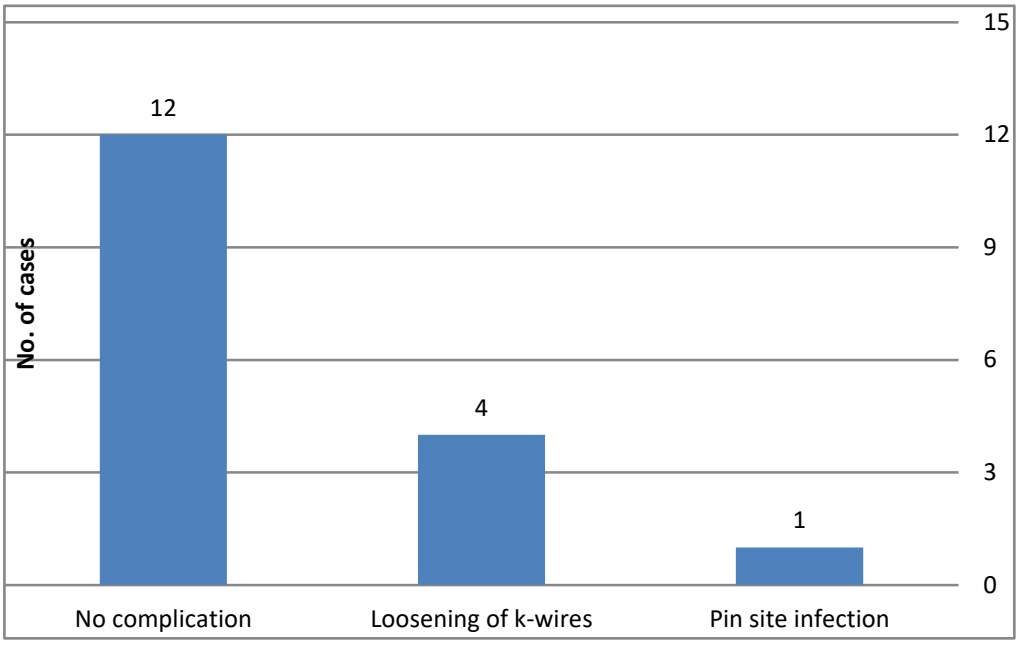


Figure 11 Distribution of patients according to post-operative complications

Table 14 Distribution of patients according to time to Union (in weeks)

UNION TIME (WEEKS)	No. of cases	Percentage
< 4	2	13.3%
4-8	12	80.0%
>8	1	6.7%

This table shows distribution of patients according to time to union (in weeks). Fracture was termed radiologically united when bridging trabecular were present across the fracture site covering at least 75% of its circumference. It was observed that 80% of patients had their fracture United in between 4 to 8 weeks from the date of surgery. Average time to union was 6.4 weeks with the range from 4 to 9 weeks.

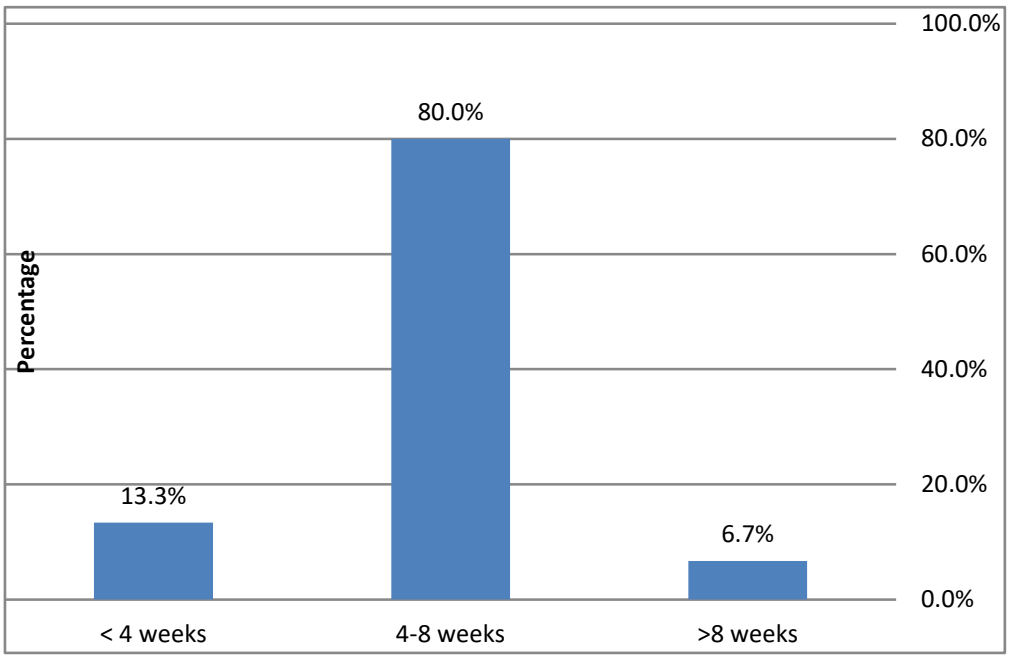


Figure 12 Distribution of patients according to time to Union (in weeks)

Table 15 Distribution of patients according to Level of Pain

Level of Pain	Score	Number of patients	Percentage
None	15	9	60%
Mild	10	6	40%
Moderate	5	0	0%
Severe	0	0	0%

This table shows distribution of cases according to the level of pain. Pain is a subjective parameter in Constant Murley score and is graded from None to Severe with maximum score of 15 and minimum of zero. At six months of follow-up more than half of the patients had had no pain (9 patients, 60%) whereas the rest of them had mild pain (6 patients, 40%). None of the cases reported any moderate or severe pain after six months of follow-up. Average score in level of pain parameter was 13 after six months of follow-up whereas average score was 8.67 and 4.33 at 3 months and 6 weeks of follow-up respectively.

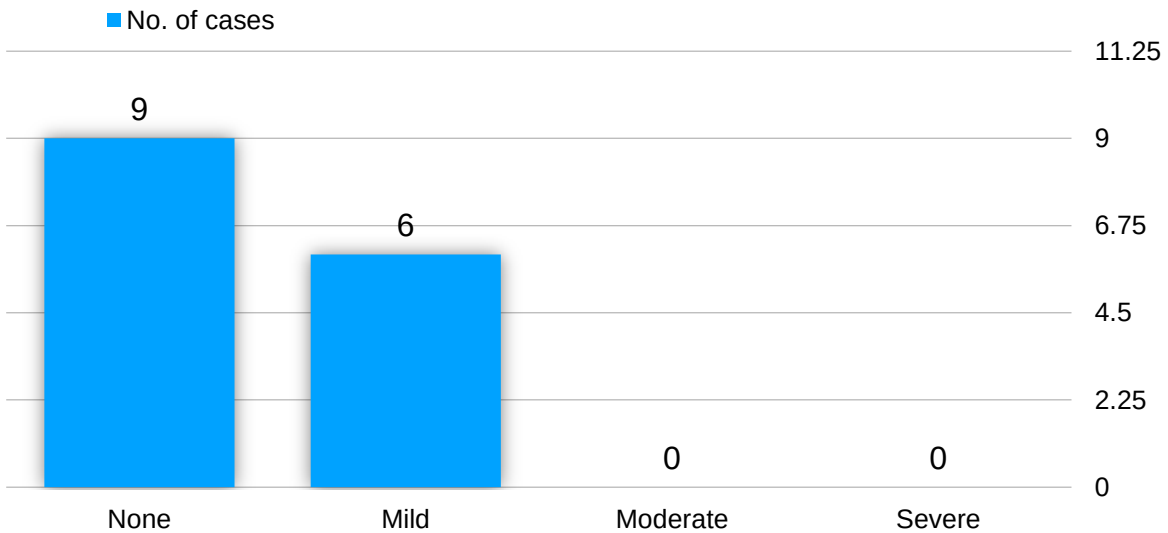


Figure 13 Distribution of patients according to Level of Pain

Table 16 Distribution of patients according to Level of Activity

Level of Activity - total score	Number of patients	Percentage
10	15	100%
8	0	0%
6	0	0%
4	0	0%
2	0	0%

This table shows the distribution of cases according to limitation of occupation and daily living by shoulder at 6 months of follow-up. This parameter is subjective and has been assessed according to constant scale. It further includes various other subparameters including status of sleep (2 points), work (4 points) and recreational activities (4 points) and patients were scored based on these and total score of Activity level was obtained. 6 months after the operative intervention none of the patients had any complaints of sleep disturbance, limitation of working capacity of the upper limb or inability to indulge in recreational activity due to the injury.

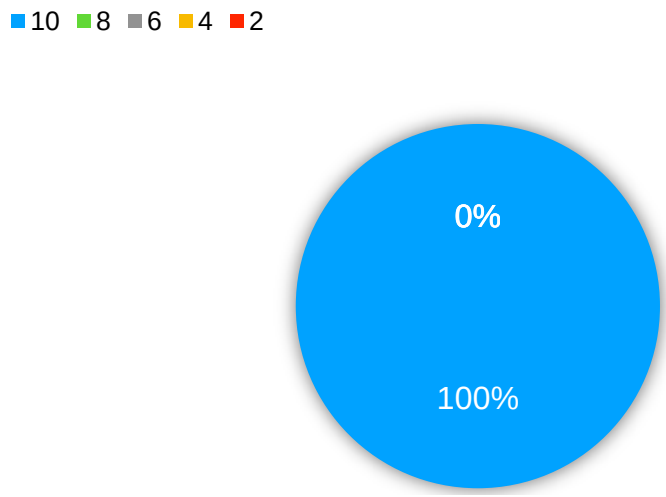


Figure 14 Distribution of patients according to Level of Activity

Table 17 Distribution of cases according to level of painless activity of the arm

Level of painless activity	Score	Number of patients	Percentage
Above head	10	5	33.33%
Up to Head	8	5	33.33%
Up to neck	6	4	26.67%
Up to xiphoid	4	1	6.67%
Up to waist	2	0	0%

This table shows the distribution of cases according to level of painless activity of the arm. After 6 months of follow-up, majority of the patients had no limitation in performing activities of daily living at the level of the head or above the level of head (10 patients 66.66%). Only one patient had severe limitation of performing activities that require taking the arm above the level xiphoid.

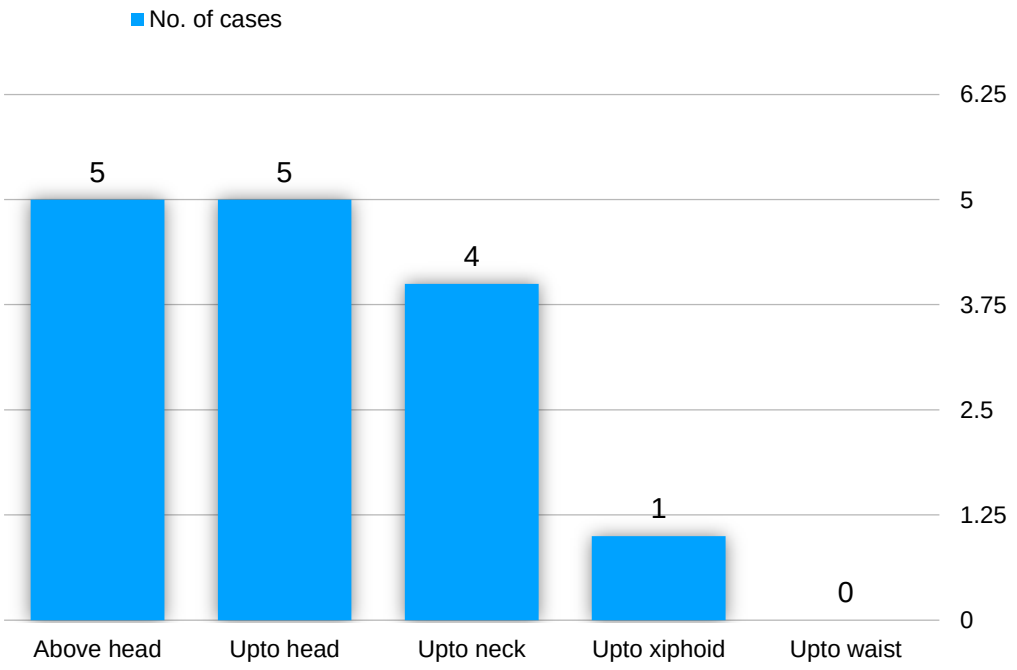


Figure 15 Distribution of cases according to level of painless activity of the arm

Table 18 Distribution of cases according to strength of abduction (in pounds)

Strength of Abduction (in pounds)	Number of patients	Percentage
0-5	3	20%
6-10	9	60%
11-15	1	6.67%
16-20	2	13.33%
21-25	0	0%

This table shows the distribution of cases according to the strength of abduction in pounds. Strength of abduction gives an objective assessment of muscle power around shoulder joint and was measured by using a weighing scale and suspending weights (in pounds). Maximum amount of weight held by the patient with arm in abduction was taken as the measure of strength with each pound getting one score with a range of 0 to 25. In our study, maximum number of patients gained strength of 6 -10 pounds (out of 25) after six months of follow up (9 patients, 60%). Average measure of strength of abduction was 9.2 pounds out of 25 after 6 months of follow-up whereas at the end of 3 months of follow-up average strength was 5.4 pounds.

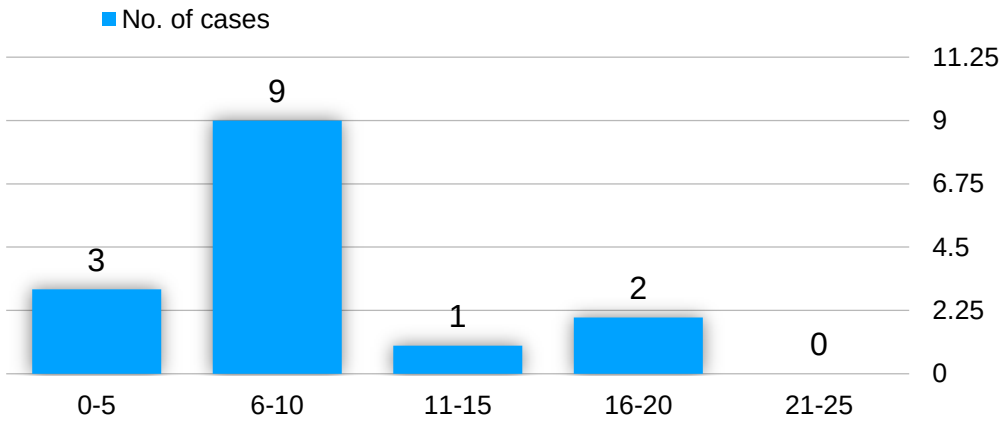


Figure 16 Distribution of cases according to strength of abduction (in pounds)

Table 19 Distribution of cases according to maximum range of forward flexion of injured shoulder

Maximum range of forward flexion	Score	Number of patients	Percentage
0 to 30°	0	0	0.00%
31° to 60°	2	1	6.67%
61° to 90°	4	5	33.33%
91° to 120°	6	6	40.00%
121° to 150°	8	2	13.33%
151° to 180°	10	1	6.67%

This table shows the distribution of cases according to maximum range of forward flexion measured in degrees with a goniometer. Majority of patients were able to obtain forward flexion between 91° - 120° (6 patients, 40%). About five patients (33.33%) gained forward flexion in between 61° - 90°. Only one patient (6.67%) was able to gain complete range of motion in sagittal plane whereas only one patient (6.67%) had less than 60° of forward flexion after six months of follow-up. Mean score of forward flexion increased from 2.8 at 3 months to 5.6 out of 10 at 6 months.

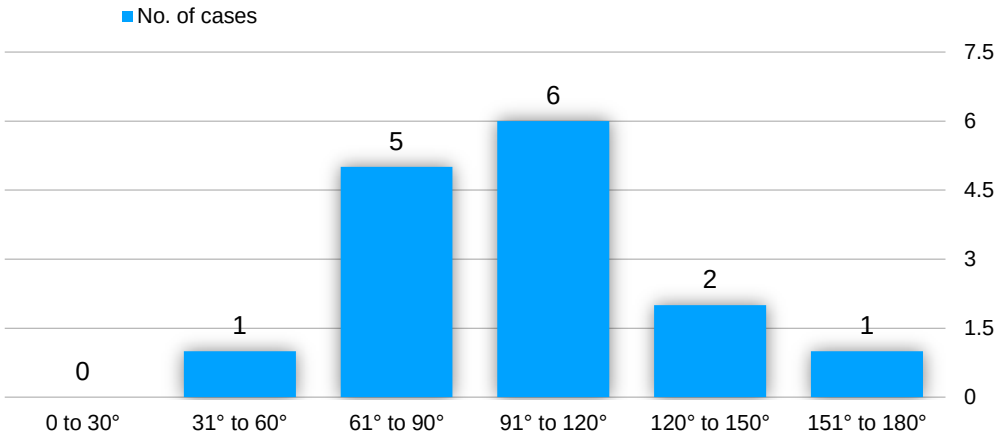


Figure 17 Distribution of cases according to maximum range of forward flexion of injured shoulder

Table 20 Distribution of patients according to maximum range of lateral elevation (in degrees)

Maximum range of lateral elevation (degrees)	Score	Number of patients	Percentage
0 to 30°	0	0	0.00%
31° to 60°	2	3	20.00%
61° to 90°	4	7	46.67%
91° to 120°	6	3	20.00%
121° to 150°	8	1	6.67%
151° to 180°	10	1	6.67%

This table shows the distribution of cases according to maximum range of lateral elevation measured in degrees with the goniometer. Majority of patients were able to obtain forward flexion between 61° - 90° (7 patients, 46.67%). 3 patients (20%) gained abduction in between 91° - 120°. 2 out 15 patients (6.67%) was able to abduct the arm more than 120°. However, only 3 patients (20%) had less than 60° of abduction even after six months of follow-up. Mean score of forward flexion increased from 2.27 at 3 months to 4.67 out of 10 at 6 months.

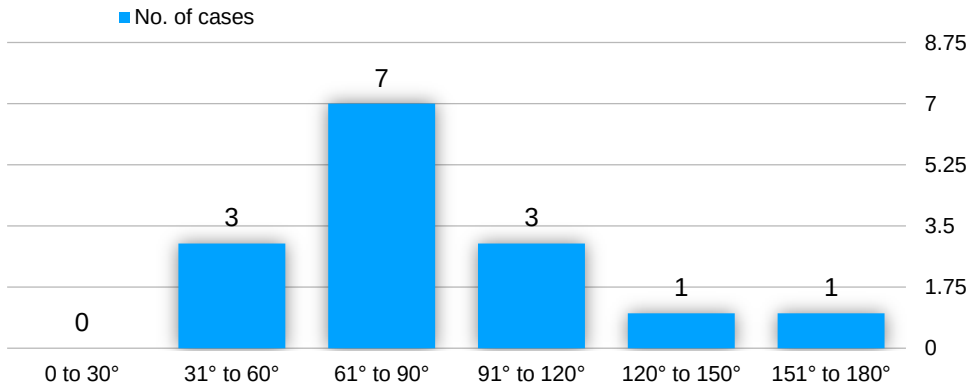


Figure 18 Distribution of patients according to maximum range of lateral elevation (in degrees)

Table 21 Distribution of patients according to maximum positions of external rotation possible

Score	Number of patients	Percentage
2	1	6.67%
4	1	6.67%
6	4	26.67%
8	7	46.67%
10	2	13.33%

This table shows the distribution of patients according to scores achieved for maximum possible positions of external rotation achieved according to Constant Murley score. Maximum number of patients were to achieve a score of 8 (7 patients, 46.67%) which implies they were able to take their hand upto the top of head with elbow externally rotated backwards. Only two patients (13.33%) were unable to take their hand till top of head whereas 2 patients (13.33%) were able to do full range of motion without any restriction. Rest of the 4 patients (26.67%) were able to take their hand on top of head but were not able to external rotate backwards from a forwards position. Mean score for External rotation increased from 4.27 at 3 months to 7.07 out of 10 at 6 months of follow up.

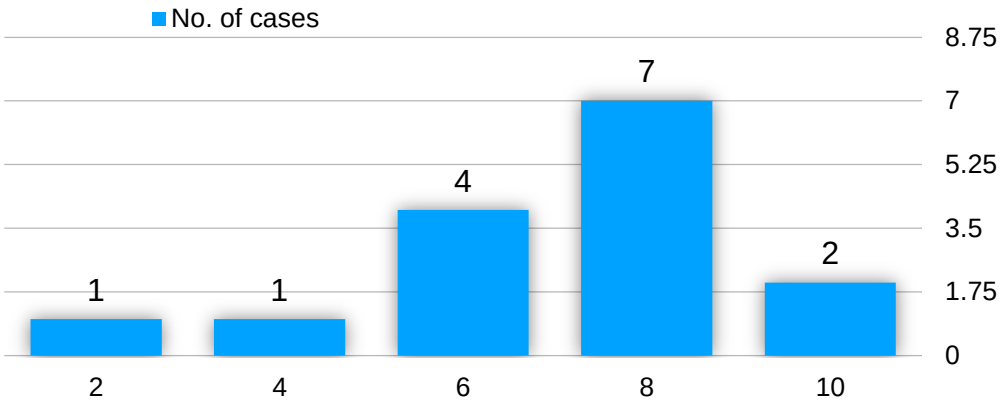


Figure 19 Distribution of patients according to maximum positions of external rotation possible

Table 22 Distribution of patients according to maximum internal rotation possible

Maximum Internal rotation (degrees)	Score	Number of patients	Percentage
Lateral thigh	0	0	0.00%
Buttock	2	0	0.00%
Lumbosacral junction	4	0	0.00%
Waist (L3)	6	3	20.00%
T12 vertebra	8	7	46.67%
Interscapular (T7)	10	5	33.33%

This table shows distribution of patients according to maximum possible internal rotation achieved. Amount of internal rotation is calculated according to the Constant Murley score based on the level of hand achieved over various landmarks on the back of the patient after internal rotating the shoulder and is scored accordingly. After 6 months of follow up, majority of patients (7 patients, 46.67%) were able to internal rotate the limb upto T12 vertebra whereas 5 patients (33.33%) were able to achieve highest level of internal rotation i.e. upto interscapular (T7) level. Rest of the 3 patients (30%) could only take their hand upto waist (L3) level. None of the patients had internal rotation of shoulder below the waist level. Mean score for internal rotation increased from 4.53 at 3 months to 8.27 out of 10 at 6 months post op.

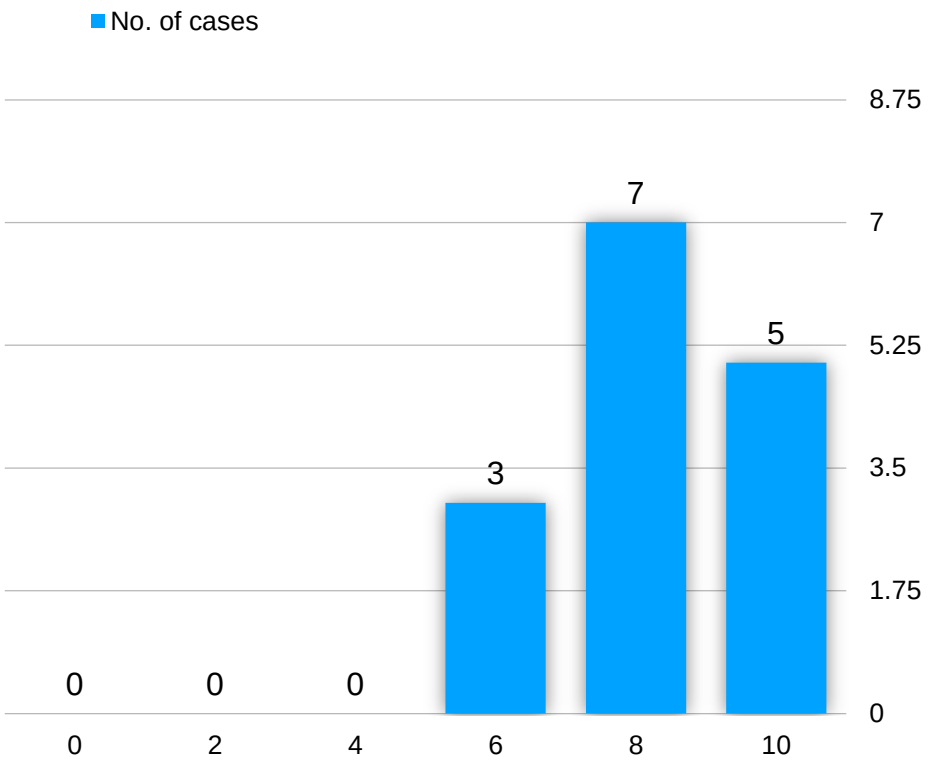


Figure 20 Distribution of patients according to maximum internal rotation possible

Table 23 Mean score for Range of motion at 3 months vs 6 months of follow up

Parameter	Mean score at 3 months	Mean score at 6 months
Forward Flexion	2.8	5.6
Lateral Elevation	2.27	4.67
External Rotation	4.27	7.07
Internal Rotation	4.53	8.27

This shows the mean score for various range of motion parameters at 3 months of follow up vs at 6 months of follow up out of a total of 10.

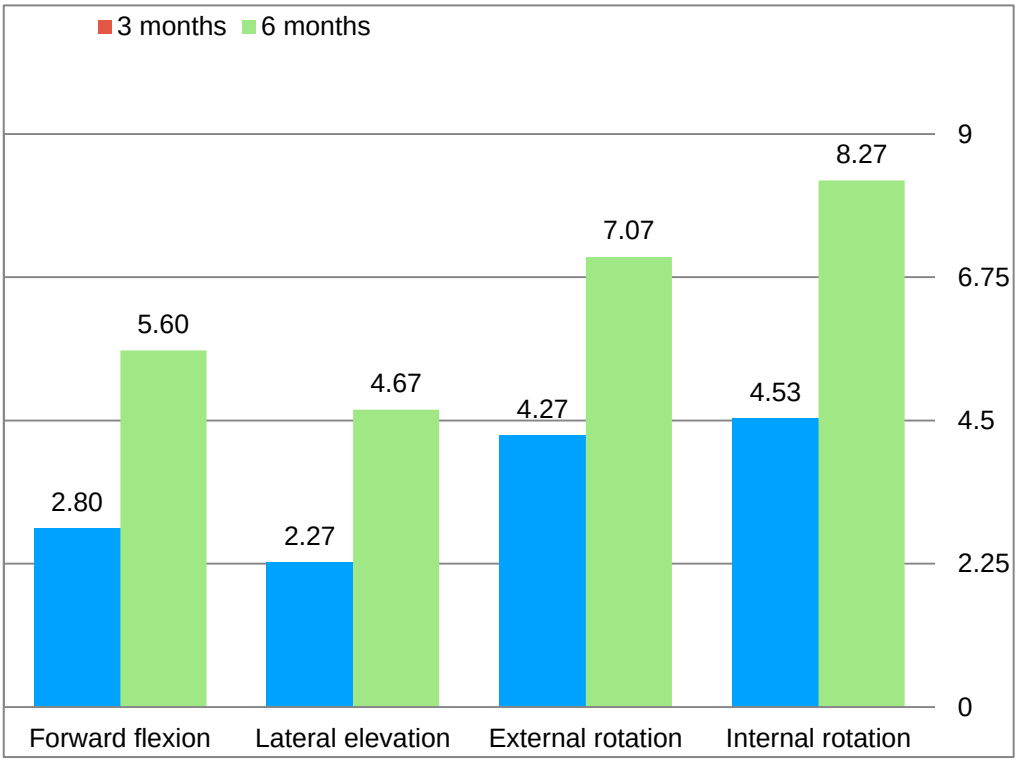


Figure 21 Mean score for Range of motion at 3 months vs 6 months of follow up

Table 24 Distribution of patients according to results of total Constant Murley score.

Results (constant score)	No. of cases	Percentage
Excellent (80-100)	2	13.3%
Good (59-79)	9	60.0%
Fair (40-59)	4	26.7%
Poor (0-39)	0	0.0%
Total	15	100.0%

This table shows the distribution of cases according to the results of total score of Constant Murley scoring system. Final scores out of 100 were calculated at the end of 6 months as per constant scoring system, and score was normalised to age and normal shoulder and calculated as normalised constant score. Mean total constant score increased from 35.67 at 3 months to 65.53 at 6 months of follow up. 60% of the patients reported Good results with total scores between 59 to 79.

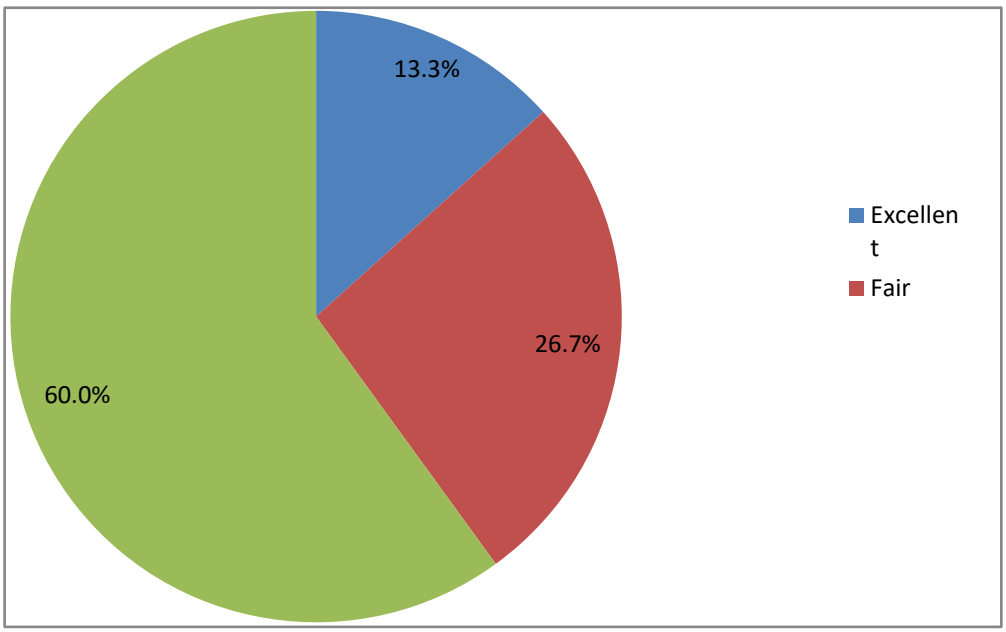


Figure 22 Distribution of patients according to results of total Constant Murley score.

Table 25 Results according to mean total constant score at 6 months and average union time (weeks) in various classes of Neer's Classification

Neer's Class	Mean total Constant score at 6 months	Average Union time (in weeks)
2 part	73.50	7.00
3 part	64.38	6.00
4 part	64.20	6.80

This table shows results in terms of mean total constant score at 6 months and average union time (in weeks) in various classes of Neer's classfication. In all classes, the result of K-wire fixation has been good and mean total Constant Murley score decreases as fracture severity increases as per Neer's classification. Average union time has been around 6-7 weeks in all types of fractures.

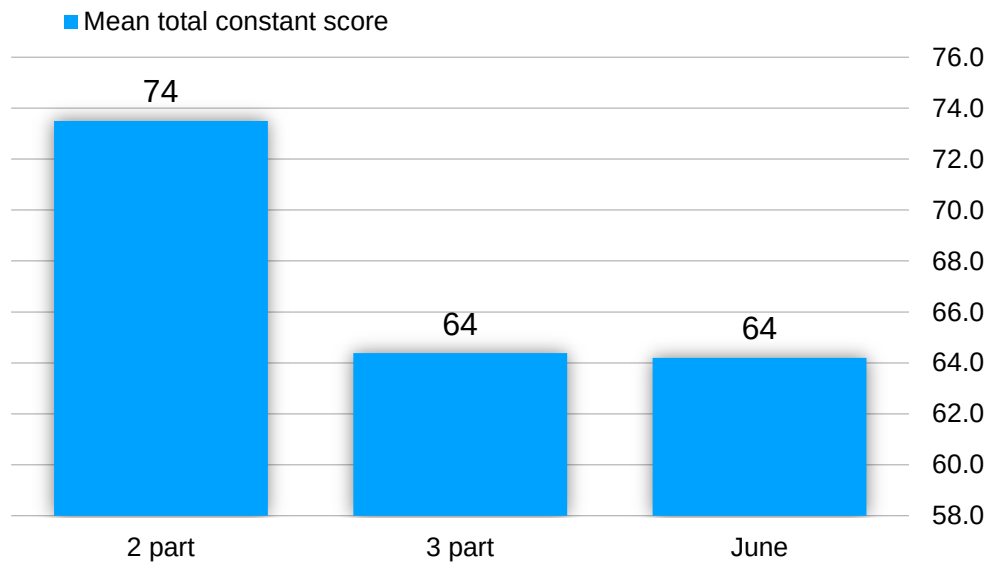


Figure 23 Results according to mean total constant score at 6 months in various classes of Neer's Classification

Table 26 Results according to mean total constant score at 6 months and average union time (weeks) in various subclasses of AO/OTA Classification

AO/OTA subclass	Mean total Constant score at 6 months	Average Union time (in weeks)
11-A2	62	6.00
11-A3	85	8.00
11-B1	63.83	6.33
11-C2	58	6.00

This table shows results in terms of mean total constant score at 6 months and average union time (in weeks) in various subclasses of AO/OTA classification. Subclass 11-A2 and 11-B1 have good results after 6 months with union time of around 6 weeks in both subclasses with this procedure. Subclass 11-A3 had only 1 patient in this study and had Excellent result with a score of 85 whereas subclass 11-C2 had fair result as per Constant Murley scoring system.

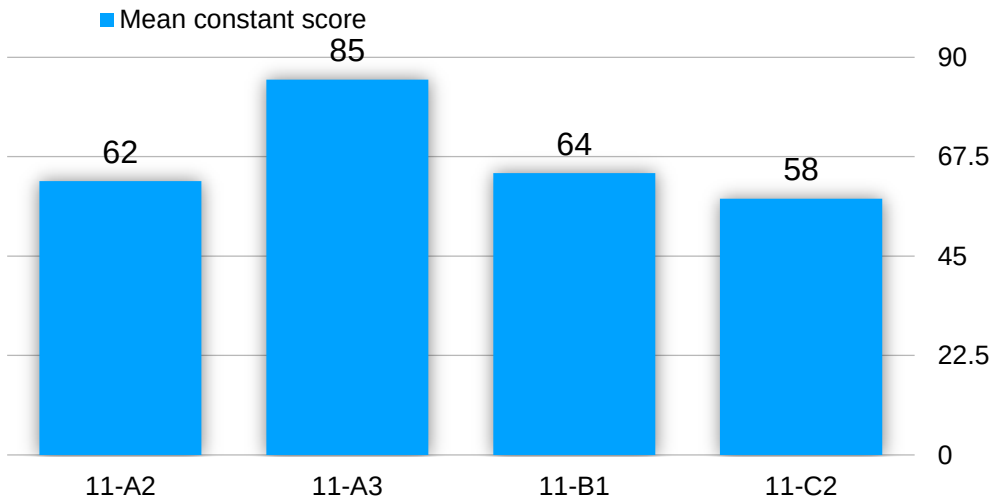


Figure 24 Results according to mean total constant score at 6 months in various subclasses of AO/OTA Classification

Table 27 Results according to mean total constant score at 6 months and average union time (weeks) in various age groups

Age groups	Mean total Constant score at 6 months	Average Union time (in weeks)
<50y	78.33	6.67
51-60y	62	6.33
61-70y	63.43	6.14
>70y	59	7.00

This table shows the results in terms of mean total constant score at 6 months and average union time (in weeks) in various age groups. Patients in young age group of <50y show a higher mean constant score at 6 months after surgery compared patients above 50 years of age. Average to union was around 6-7 weeks in age groups.

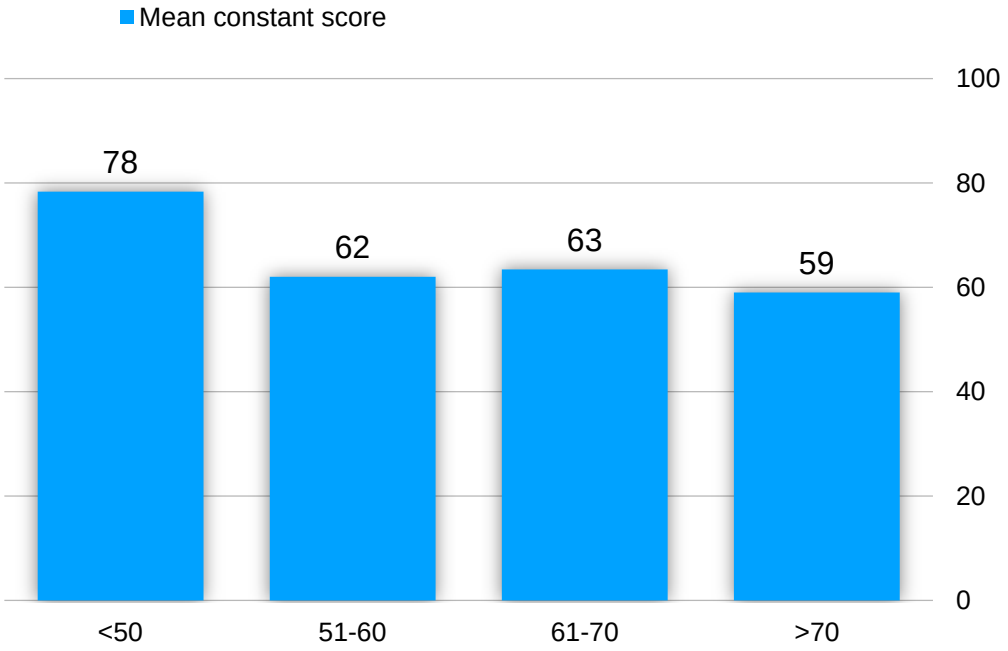


Figure 25 Results according to mean total constant score at 6 months in various age groups

Table 28 Distribution of cases according to time lag between injury and surgery

Time lag (in days)	No. of cases	Percentage
0	4	26.66%
1	5	33.33%
2	3	20.00%
3	3	20.00%

This table shows distribution of cases according to the time lag between injury and the surgery. 60% of the patients were operated by the next day of injury.

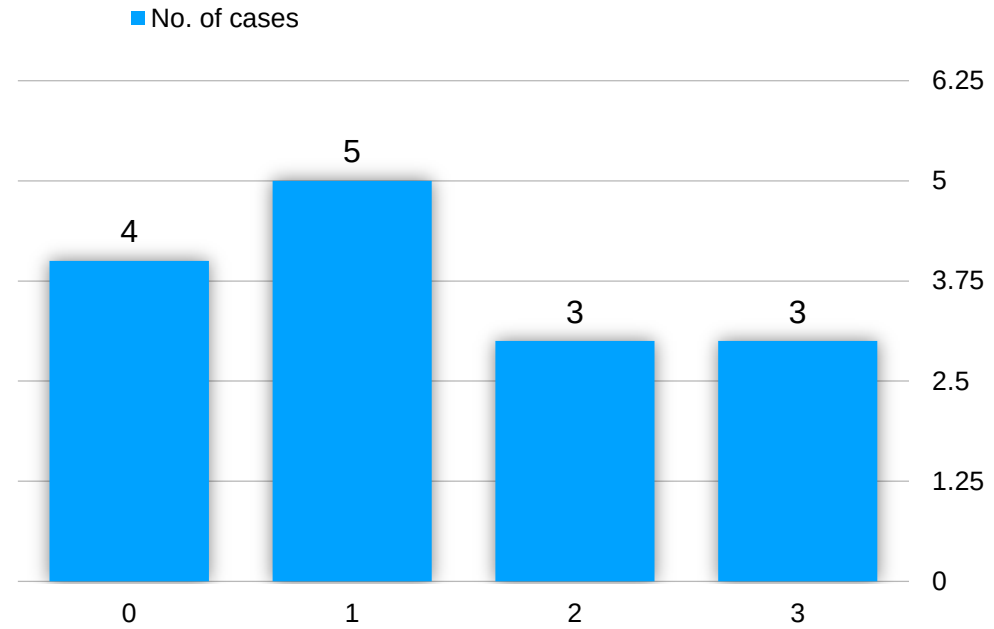


Figure 26 Distribution of cases according to time lag between injury and surgery

DISCUSSION

Management of proximal humerus fractures present a major challenge in modern orthopaedics practice as no method of fixation is considered gold standard treatment. The factors relating to anatomy and blood supply of the region, age distribution of injury and osteoporosis which makes anchorage of implants difficult, the fractures of this region require individualised protocol in every patient with certain guidelines.

Shoulder is an important joint of the upper limb as it is plays a major role in the simple activities of daily living like wearing a shirt, eating, brushing of teeth or combing of hair etc. thus producing severe handicap in patients with impaired shoulder function. Therefore the need for anatomic reduction is of paramount importance in these fractures, but, the precarious blood supply of the region prevents extensive open manipulation of the fragments.

Closed reduction and percutaneous pinning provides a middle ground treatment protocol that helps to preserve the biological environment of proximal humerus and provides a way to fix the fractures with less operative time and shorter post operative recovery periods.

In this study, 18 patients of proximal humerus fractures treated with closed reduction and K -wire fixation out of which 15 patients were available for final compilation and analysis.

Age & Sex incidence

Out of a total of 15 patients, only 3 patients were less than 50 years of age while rest of the 80% of the patients were above 50 years with a range of 28 to 82 years. Maximum number of patients i.e. 7 out 15 (46.7%) were in the age group between 61 to 70 years.

Out of a total of 15 patients available for follow up, 9 were females (60%) whereas 6 were males (40%). In age group less than or equal to 50 years, out of 3 patients, 2 were male and 1 patient was a female (Male:female = 2:1) but in age group more than 50 years, 8 were females and 4 were males (Male:female = 1:2)

	Mean age	Female : Male ratio
Our study	60y	1.5
Resch et al	54y	0.68
Soete et al	68y	3.4
Fenichel et al	50y	1.7
Calvo et al	70.9y	-
El-Alfy et al	56y	1.6
PROFHER trial	66y	3.3

Soete et al[50] studied 31 patients of proximal humeral fractures treated with percutaneous K wire fixation pinning between 1993 to 1996. The mean age of the group was 68 years ranging from 29 to 82 years. This study included 24 female patients and 7 male patients

Fenichel et al[52] followed up 50 patients with proximal humerus fractures treated with percutaneous methods. The mean age of was 50 years with a range of 21 to 78 years. Out of 50 patients, 32 were females and 18 were males

In a study by Calvo et al[53], 74 patients were studied between 2001 to 2004 with a mean age of 70.9 years for functional outcome of closed reduction and percutaneous pinning with Kirschner wires of fractures of proximal humorous.

El-Alfy et al [60] studied 18 patients with mean age of 56 years, ranging from 38-75 years, for functional outcome of proximal humerus managed with closed reduction and percutaneous fixation with the modified palm tree technique.

These fractures are more common among the elderly population with associated comorbid conditions and age related osteopaenia/ osteoporosis. Patients younger than 50 years of age show significantly less rates of complications and better functional outcomes as compared to elderly population. As per literature, there is higher risk of secondary loss of reduction and consequent malunion or non-union, osteonecrosis of humeral head and loosening of K-wires due to

diminished bone quality. As observed in our study, elderly patients have higher rates of associated comorbidities like Type II Diabetes Mellitus, Hypertension, Chronic Kidney Disease, Coronary Artery Disease etc. thus making them more susceptible to infection and delayed wound healing as compared to younger population. Elderly patients also pose a challenge in late post operative rehabilitation period as they tend to be less compliant with the physiotherapy protocols and more sensitive to pain. Recent literature has also shown that Constant Murley score declines with increase in age and this has been observed in our study as well, as depicted in Table 27. Although elderly patients are satisfied with low functional outcome of shoulder as most of them are retired or are homemakers thus having low functional demands.

Among young patients, males have reportedly higher incidence of this injury as they are vulnerable to roadside accidents or direct trauma as compared to females by virtue of their occupational needs. Whereas among elderly, females have significantly higher incidence as low energy trauma including domestic falls or fall from stairs is the mode of injury in most patients. Elderly females are more susceptible to comminuted fractures because of higher incidence of osteoporosis attributed to menopause. According to observations of our study and evidence from recent literature, it can be concluded that elderly females are most susceptible to fractures of proximal humerus.

Mode of injury & associated injuries

In our study, mode of injury was categorised into road traffic accidents and domestic fall including fall from stairs representing low energy trauma. Out of 15 patients, 9 (60%) had domestic fall whereas 6 patients (40%) met with a road traffic accident.

Among below 50 years of age group, 2 out of 3 patients presented with road traffic accident. Among elderly patients (above 50 years), 2/3rd of patients presented with a history of domestic fall.

Out of 9 patients having injury following domestic fall, only 1 had an associated intertrochanteric fracture, rest all had an isolated fracture of

proximal humerus only. Whereas 2 patients out 6 had associated fractures of lower limb due to road traffic accident.

In a study by Soete et al [50], 31 patients were studied out of which 25 patients (80.64%) presented with a domestic fall while 6 patients (19.35%) were injured in road traffic accidents.

In a similar study by Resch et al [49], out of 27 patients, 20 patients had skiing/snowboarding accident (74.07%), 4 were involved in road traffic accident (14.81%), and only 3 patients (11.11%) had a history of fall.

In another study by El-Alfy et al [60], out of 18 patients, 12 patients had a history of fall (66.67%) whereas rest of the 6 patients had direct trauma to shoulder (33.33%).

In PROFHER trial [64], out of 250 patients, 186 patients (74.4%) had a fall from standing height or less whereas 35 patients (14%) had a fall down stairs or from a step height. In 24 patients (9.6%) mechanism of injury was classified as other.

As per literature, domestic fall is the leading cause of this injury especially in elderly and this was observed in our study as well. However road traffic accidents constitute the main mode of injury in younger population and can be commonly associated with polytrauma including blunt trauma chest, blunt trauma abdomen or head injury. Osteoporotic bone structure is responsible for more communited fractures of proximal humerus despite low energy trauma like domestic fall.

Classification of the fracture

In our study, fractures were classified according to both Neer's classification and AO/OTA classification for proximal humerus. Most of the patients were classified as Neer's 3 part fracture (8 patients, 53.3%) closely followed by 5 patients (33.3%) having Neer's 4 part fracture whereas only 2 patients (13.3%) with Neer's 2 part fracture were treated with this method.

As per AO/OTA classification, 2 patients (13.3%) had Type A fractures. Out of 15, 12 patients (80%) presented with Type B fractures whereas only 1 patient (6.7%) had a Type C fracture.

In the study by Resch et al [49], 72 patients were operated with percutaneous techniques. Of these,45 patients (62.5%) were 2 part fractures, 9 (12.5%) were 3 part fractures and 18 (25%) were 4 part fractures.

In another study by Fenichel et al [52], out of a total 50 patients, 24 patients were 2 part and 26 were 3 part fractures. They observed that 2 part fractures had better results with than 3 part fractures.

E-Alfy et al [60] studied 18 patients, out of which 13 cases had 2 part fractures and 5 had 3 part fractures.

In PROFHER clinical trial [64], out of 250 patients, 128 patients (51.2%) were 2 part fractures, 93 patients (37.2%) were 3 part fractures, and 11 patients (4.4%) were 4 part fractures.

Both Neer's classification and AO/OTA classification divide the proximal humerus fractures according to the severity of the fracture and degree of communition. Recent literature has shown that Neer's 4 part fractures and Type C fractures are associated with poor functional outcomes and have increased incidence of complications, most commonly osteonecrosis. As seen in Table 25 and 26, higher the fracture class, lower the final Constant score. Closed reduction is difficult for comminuted fractures and inability to achieve anatomical reduction initially can be a factor for a lower outcome scores later. Also with more communition, risk of secondary loss of reduction increase which is another factor that can lead to malunion and lower functional outcomes. In our study there was no case of AVN of humeral head after 6 months of follow up even in highly communited 4 part fracture or intra-articular fracture. This is one of the biggest advantage of this modality of treatment as it preserves biological environment of the bony fragments which increases the chances of union and reduces the risk of AVN. As depicted in Table 25 and 26 average time to union in all classes was 6-7 weeks thus consolidating the view that maintaining the soft tissue supports around the fracture fragments help in achieving union.

Union time and post operative recovery

In our study, average time to union for all patients was 6.4 weeks with a minimum of 4 weeks and maximum of 9 weeks. Most of the patients (12 patients, 80%) achieved union within 4 to 8 weeks post procedure. Average time to union among various subclasses according to Neer's and AO/OTA classification was also between 6 -7 weeks.

In our study, non-threaded 2mm K-wires were used to stabilise the fracture fragments. Most of the fractures (7 cases, 46.7%) required 4 K-wires to adequately stabilise the reduction. Average number of K-wires required to stabilise the fracture as per Neer's classification increase with increase in fracture class, as shown in Table 11. All patients were advised shoulder immobiliser till K-wires were removed and physiotherapy regimen was started after K-wire removal.

In most of the patients (10 patients, 66.7%) K-wires were removed within 4 - 8 weeks post procedure with an average of 6 weeks.

Soete et al [(50)], studied 31 patients for results of closed reduction and percutaneous pinning. After closed reduction they used four 2.5mm terminally threaded pins to stabilise the fracture. The limb was splinted with Velpeau dressing. Average time to union was between 3 - 4 weeks and pins were removed after radiological union was observed.

In the study by Fenichel et al [(52)] for closed reduction and percutaneous pinning, 3 -5 partially threaded K-wires were used to achieve stable fixation of fracture fragments and shoulder was immobilised with shoulder immobiliser for a period of 6 weeks.

In our study, most of the patients were discharged 1 to 2 days after the procedure except in patient having associated injury. Post operative physiotherapy and rehabilitation programs play a major role in improving the functional outcomes of patients with proximal humerus fractures. Although passive mobilisation exercises can be started with K-wires in situ, it was avoided in majority of the patients in our study to mitigate the risk of migration or loosening of K-wires and subsequent loss of reduction. Once union is confirmed radiographically, K-wires were removed on a day care basis and active range of motion exercises were started. Compliance for physiotherapy protocols was

less with elderly patients compared to young patients in our study, thus reducing the overall score in that group. Thus this treatment protocol has the advantage of shorter hospitalisation, less scar marks and less surgical trauma.

Functional outcome

Functional outcome in our study has been calculated as per Constant Murley score (Total of 100). Various components of Constant Murley score includes subjectively scored parameters like pain, activity level, arm positioning along with objectively calculated parameters like strength of abduction and range of motion.

Pain & Activity level

In our study, 60% patients had no pain after 6 months of follow up whereas rest of the 40% had mild pain. Average score in level of pain parameter was 13 after six months of follow-up whereas average score was 8.67 and 4.33 at 3 months and 6 weeks of follow-up respectively. None of the patients in our study had any complaints of sleep disturbance, limitation of working capacity of the upper limb or inability to indulge in recreational activity 6 months post injury.

Resch et al [(49)] studied percutaneous fixation of fractures in 27 patients. They observed an average score of 14.2 in 3 part fractures and 12.7 in 4 part fractures for pain.

In the study by Soete et al [(50)] on 31 patients, they observed a mean constant score for pain to 11 with 42% of patients having no pain. They observed a mean score of 18 points for activity level.

In another study by Fenichel et al [(52)], 13 of 24 patients with 2 part fractures had no pain at all whereas 19 had no limitation of daily activities and 13 patients enjoyed some form of recreational sports. Among three parts fractures 15 of the 26 patients had no pain and no limitation of daily activities.

Pain scores in our study are comparable to Chronic pain is one of the most important factors that can lead to disuse atrophy of the muscles of injured shoulder in the long term. Rotator cuff impingement is a common cause of chronic pain which can be caused by reduction in the subacromial space due to malunion of greater tuberosity fragment.

Anatomical reduction of greater tuberosity fragment is of great importance to maintain rotator cuff function. In our study pain scores significantly improved from 3 months to 6 months post operatively. This observation is attributed to the fact that graded physiotherapy regime makes the muscles around shoulder joint strong and reduces stiffness.

Range of motion

In our study, 40% of patients were able to obtain forward flexion between 91° - 120° (6 patients, 40%) whereas 5 patients (33.33%) gained forward flexion in between 61° - 90°. Only 1 patient was able to gain complete range of motion in sagittal plane whereas only 1 patient had less than 60° of forward flexion.

Out of 15, 7 patients were able to obtain lateral elevation between 61° - 90° (46.67%). 3 patients (20%) gained abduction in between 91° - 120°. 2 out 15 patients (6.67%) was able to abduct the arm more than 120°. However, 3 patients (20%) had less than 60° of abduction even after six months of follow-up.

As far as external rotation is concerned, maximum number of patients were able to achieve a score of 8 (7 patients, 46.67%). Only two patients (13.33%) were unable to take their hand till top of head. 2 patients (13.33%) were able to do full range of motion without any restriction.

After 6 months of follow up, majority of patients (7 patients, 46.67%) were able to internally rotate the shoulder upto T12 vertebra whereas 5 patients (33.33%) were able to achieve highest level of internal rotation i.e. upto interscapular (T7) level. Rest of the 3 patients (30%) could only take their hand upto waist (L3) level. None of the patients had internal rotation of shoulder below the waist level.

Mean score for range of motion in our study was 25.6 out 40.

Resch et al [(49)] observed residual average restriction of flexion of 10°, abduction of 15° and external rotation of 15° in 3 part and average restriction of 15° of flexion, 18° of abduction and 12° of external rotation in 4 part fractures as compare to the contralateral side. Average score for range of motion was 38 in 3 parts fractures and 37.2 in 4 parts fractures.

In the study by Soete et al [50] on 31 patients, mean score for range of motion was 33 out of 40. For forward flexion average score was 9 with 64.5% patients having more than 150° of forward flexion and 35.5% cases having 180°. Mean score for lateral elevation was 8 points with 45.2% of patients having more than 150° and 29% of patients having lateral elevation between 121° to 150°. Mean score for external rotation was 9 points with 74% of cases having full elevation from on top of head. Mean score for internal rotation was 7 points with 35.5% cases reaching T7 level. They had two patients with 4 part fractures who had forward elevation less than 90°, lateral elevation between 61° to 90°, external rotation score of two and one patient having internal rotation upto buttock.

In the study by Fenichel et al [52], among 2 part fractures, all 24 patients had no significant limitation of abduction while 19 patients had forward flexion and abduction greater than 150°. 16 out of 24 patients could could reach their shoulder blades terms of internal rotation. Among three parts fractures 15 of the 26 patients could achieve flexion and abduction greater than 150°. 14 out of 26 patients could reach shoulder blades in terms of internal rotation while only 1 patient could reach up to sacroiliac joint.

In our study, mean range of motion score was low as compared to results achieved in other study. In our study, younger patients had better range of motion scores compared to elderly especially in forward flexion and lateral elevation components as they had 2 part and 3 part fractures only and better compliance with physiotherapy regime. In our study, average scores for both internal and external rotation were comparable to other studies. Scores for forward flexion and abduction were low compared to other study as patients were able to compensate abduction and to certain extent forward flexion with scapulothoracic movements, especially in patients above 50 years of age. Rotations of shoulder can be severely restricted due to malunion of tuberosities as internal rotator i.e. Subscapularis is attached to lesser tuberosity and external rotators namely Infraspinatus and Teres Minor are attached to

greater tuberosity. Anatomical reduction of these fragments is important.

Constant Murley Score

In our study, out of 15 patients, 2 (13.3%) had excellent result, 9 (60%) had good result and rest of the 4 (26.75) had fair result. None of the patients had poor results. Average constant score was 65.53 after 6 months of follow up. Average constant score for 2 part fracture was 73.5, for 3 part fractures was 64.38 and for 4 part was 64.2.

In the study of Soete et al [50], 31 patients had an average Constant score of 80 with an average follow up 45 months.

Resch et al [51], studied 88 patients for results of percutaneous reduction and fixation. They found that all B1 and B2 (37 patients) showed good to very good functional results with an average constant score of 91. Whereas patients with Type C fractures (41 patients) the average Constant score was 87.

In the study by Fenichel et al [52], out 50 patients, 18 patients (36%) had excellent results, 17 (34%) had good, 8 (16%) had a fair and 7 (14%) had poor results. They found the average constant score to be 81 with a range of 60 to 100.

In the study by Calvo et al [53], 51 patients were followed up for average of 13.6 months. They observed the mean constant score to be 65.8 in the injured shoulder. They also found an association between the type of fracture and the clinical result.

El-Alfy et al [60] studied palm tree modification of K-wire fixation of proximal humerus fractures in 18 patients. They found average Constant score to be 73 after an average period of 22 months with a range of 45 to 88. The results were excellent in 5 patients (27%), good in 9 (50%) and poor in 1 (6%)

	Average Total Constant Score
Our study	65.53 ; 73.4 (2 part), 64.38 (3 part), 64.2 (4 part)
Resch et al	91 (Type B), 87 (Type C)
Soete et al	80
Fenichel et al	81
Calvo et al	65.8
El-Alfy et al	73

In our study 11 out of 15 patients (73.33%) had good to excellent results. Constant score was in par with other studies for patients less than 50 years of age with mean score of 78.3. In patients above 50 years of age, average constant score has been low as compared to other studies due to low scores in range of motion, specifically forward flexion and abduction, and strength of abduction parameters. This can also be attributed to the fact that we followed up the patients for upto 6 months. Range of motion and strength of abduction scores can be improved with physiotherapy regimes beyond 6 months.

Complications

In our study, majority of the patients experienced no complications in the immediate, early and late post-operative periods (12 out of 15 patients). Most common complication was loosening of K-wires that occurred in 4 patients but no incidence of migration of the wires was observed in these patients. Out of these 4, loosening of K-wire was associated with superficial pin tract infection. It was managed with oral antibiotics and local wound care. In all of these 4 patients, there was no evidence of any loss of reduction.

In the study by Resch et al [(49)], among the 3 part fracture group, out of 9 patients, 2 patients had migration of K-wires. No case of AVN in 3 part fractures was observed. However among the 4 part group, out of 18 patients, 2 developed signs of AVN.

Soete et al (1999) studied 31 patients and observed the following complications - superficial pin tract infection in 1 patient, secondary loss of reduction in 4 patients, and AVN in 5 patients. Out of 5 patients with AVN, 3 cases were among the 4 part group.

In the study by Fenichel et al [52], out of 50 patients, they observes the following complications in their study - secondary displacement due to failure of fixation in 7 patients, all in 3 part fractures. No case of non-union, AVN, deep infection or neuromuscular injury was observed.

In the study by Calvo et al [53], out of 51 patients, they observed the following complications - migration of K-wires in 18 patients, loss of reduction in 5 patients, non-union in 1 patient, superficial pin tract infection in 2 patients, AVN in 4 patients, malunion in 14 patients.

El-Alfy et al [60] studied palm tree modification of K-wire fixation of proximal humerus fractures in 18 patients. They observed following complications in the group - 2 patients with pin tract infection, 1 case with wire migration in shoulder joint and local area of skin necrosis in 3 cases. No cases were complicated by loss of fixation, deep infection or AVN of humeral head.

As reported in other studies, common complications in this method of treatment include loosening or migration of K-wires, secondary loss of reduction, malunion, damage to Axillary nerve, Posterior Humeral Circumflex artery and tendon of long head of Biceps. Closed reduction is a technically demanding procedure and initial anatomical reduction can be difficult in case of large displacements. This can be improved by using K-wires as joysticks or percutaneous insertion of hooks around the tendinous insertions.

Migration or loosening of K-wires is a common complication in osteoporotic bone as there is less hold of wires over the bone and can lead to secondary loss of reduction. Migration into the joint cavity can result in damage to articular cartilage whereas there have been reported cases of migration into the chest cavity or axilla, although these are isolated instances. This can be prevented to certain extent by the use of terminally threaded K-wires or the insertion of a locking device that can be fixed to the shaft of humerus with a separate incision away from fracture site. These were not available for use in our study. Regular radiological monitoring of the reduction is required and revision surgery should be done in case of any major displacement of fragments.

SUMMARY

This is a study of evaluation of functional outcome and union times in closed reduction and K-wire fixation of proximal humerus fractures, performed on 15 patients followed upto 6 months.

- 80% of the patients were above the age of 50 years.
- Domestic fall including other modes of low energy trauma was the main mode of injury among the elderly patients.
- More than half of the patients had associated multiple comorbidities.
- More than half of the patients had 3 part fracture according to Neer's classification
- 80% of the patients were categorised as having Type B fracture as per AO/OTA classification
- Fracture united between 4 to 8 weeks in 80% of the patients with average union time of 6.4 weeks
- Average time to union remained between 6 to 7 weeks in all classes of fractures as per Neer's classification
- About 73% of the patients had good to excellent results 6 months after the procedure with an average Constant score of 65.53
- No patient had poor result as per Constant Murley score.
- Average Constant score was highest among 2 part fractures, and decreased with increase in severity of fracture.
- Patients below 50 years of age had overall better Constant scores than patients above 50 years.
- Most common complication was loosening of K-wires.
- No incidence of migration of K-wires, AVN, secondary loss of reduction, non-union, malunion or damage to nerves and vessels.

CONCLUSION

Fractures of proximal humerus pose a challenge for modern orthopaedic surgeon due to the age distribution, anatomical considerations, potentially debilitating complications of the fracture and a variety of treatment options available.

Closed reduction and K-wire fixation has several advantages over open methods of fixation especially relating to elderly patients. Although anatomical reduction of fracture is technically demanding, but it is less invasive and patient requires a shorter hospital stay post-operatively. The biological environment around the fracture fragments and blood supply of the head of humerus is minimally disturbed leading to increased chances of union. As seen in our study the results in around 70% of the patients have been good to excellent after 6 months of surgery.

Although this method has its disadvantages. Loosening or migration of K-wires especially in osteoporotic bone can lead to secondary loss of reduction and subsequent malunion or non-union. Closed reduction in itself is very difficult in highly communited fractures especially 4 part fractures.

Anatomical reduction, stable fixation of all fragments and post operative physiotherapy regimen are the most important factors in improving the final functional outcome in patients of proximal humerus fractures treated with this method.

We conclude that closed reduction and K-wire fixation is a good alternative to open methods of fixation in treatment of 2 part, 3 part fractures and in certain 4 part fractures.

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Patient 2 as per Master Chart

Pre-Operative X-ray

Post-operative X-Ray

Follow up after 3 Weeks

Follow up after 2 months

Follow up after 5 months

Clinical outcome after 6 months

Patient 3 as per Master Chart

Pre-Operative X-ray

Pre-Operative X-ray

Follow up after 3 Weeks

Follow up after 5 Weeks

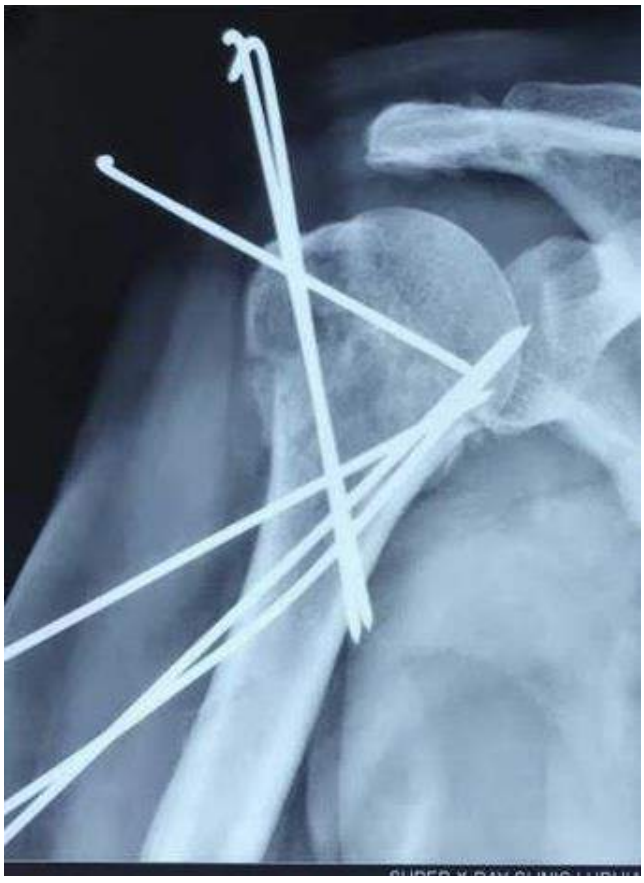
Follow up after 5 months

Clinical outcome after 6 months

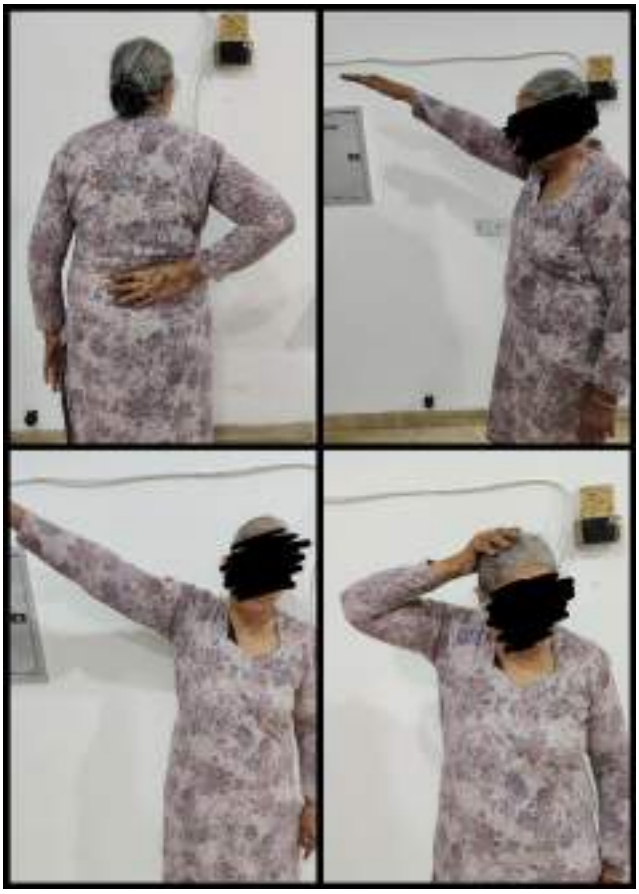
Patient 6 as per Master Chart

Pre-Operative X-ray

Post-Operative X-ray



Follow up after 6 Weeks



Clinical outcome after 6 months

Follow up after 6 Months

Patient 7 as per Master Chart

Pre-Operative X-ray

Post-Operative X-ray

Follow up after 4 Weeks

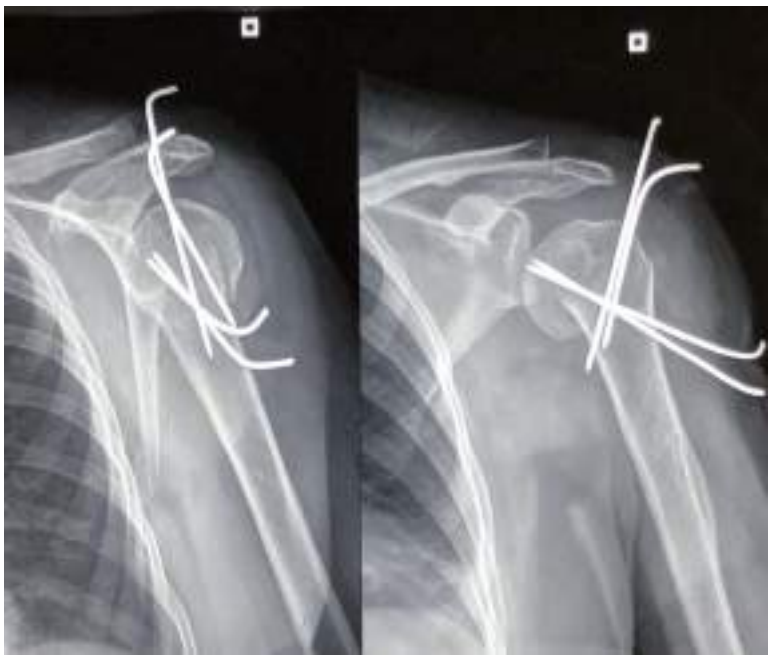
Follow up after 8 Weeks

Follow up after 6 months

Clinical outcome after 6 months

Patient 11 as per Master Chart

Pre-Operative X-ray



Post-Operative X-ray

Follow up after 3-4 Weeks

Follow up after 4 months

Clinical outcome after 6 months

S. NO.	MRD NO.	INITIALS	AGE	SEX	DATE OF ADMISSION	DATE OF DISCHARGE	MODE OF INJURY	ASSOCIATED ILLNESS		FRACTURE CLASSIFICATION		TIME LAG BETWEEN INJURY AND SURGERY (DAYS)	DATE OF SURGERY	NO. OF K-WIRES USED	DATE OF K-WIRE REMOVAL	Time period after which wire removed (weeks.days)	Immobilisation	Physiotherapy	COMPLICATION DETAILS			UNION TIME (WEEKS)	
								ASSOCIATED COMORBIDITIES	ASSOCIATED OTHER INJURIES	NEER	AO/OTA								INTRA-OP COMPLICATION	Immediate Post-op Complications	Late Post-op Complications		6 WEEKS
1	582755	VS	28	M	16 Sep 2018	18 Sep 2018	RTA	-	Closed Fracture Medial malleolus left side	2 part	11-A3	1	17 Sep 2018	5	15 Nov 2018	8.3	Shoulder immobiliser	After 8 weeks	-	-	-	8	0
2	598211	GK	50	F	9 Oct 2018	11 Oct 2018	RTA	Hypothyroidism, hypertension	-	3 part	11-B1	1	10 Oct 2018	4	19 Nov 2018	5.5	Shoulder immobiliser	After 8 weeks	-	-	-	6	5
3	293755	KS	29	M	23 Oct 2018	25 Oct 2018	DF	-	-	3 part	11-B1	2	23 Oct 2018	5	30 Nov 2018	5.3	Shoulder immobiliser	After 5 weeks	-	-	loosening of k-wires	6	10
4	582822	KK	78	F	19 Sep 2018	18 Sep 2018	DF	-	-	4 part	11-C2	1	17 Sep 2018	4	29 Oct 2018	6	Shoulder immobiliser	After 6 weeks	-	-	-	6	0
5	617969	SS	66	M	12 Nov 2018	12 Nov 2018	RTA	Hypertension	-	3 part	11-B1	1	12 Nov 2018	4	26 Dec 2018	6.2	Shoulder immobiliser	After 6 weeks	-	-	-	6	5
6	618082	GK	62	F	12 Nov 2018	13 Nov 2018	DF	Hypothyroidism	-	4 part	11-B1	0	12 Nov 2018	7	24 Dec 2018	6	Shoulder immobiliser	After 3 weeks	-	-	-	6	5
7	215505	PK	59	F	2 Dec 2018	4 Dec 2018	DF	-	-	3 part	11-B1	3	3 Dec 2018	4	1 Feb 2019	4.1	Shoulder immobiliser	After 4 weeks	-	-	-	4	5
8	631054	BMG	88	M	3 Dec 2018	8 Dec 2018		Expired															
9	635502	J	19	M	10 Dec 2018	24 Dec 2018		Lost to follow up															
10	652178	SS	52	M	11 Jan 2019	14 Jan 2019	RTA	Hypertension	-	4 part	11-B1	2	13 Jan 2019	4	18 Mar 2019	9.2	Shoulder immobiliser	After 2 weeks	-	-	Pin site infection, loosening of k- wires	9	5
11	4144	RA	69	F	19 Feb 2019	22 Feb 2019	DF	Hypertension, hypothyroidism	-	3 part	11-B1	1	20 Feb 2019	4	18 Mar 2019	3.5	Shoulder immobiliser	After 4 weeks	-	-	-	4	0
12	345275	RL	70	M	27 Mar 2019	28 Mar 2019	DF	-	-	2 part	11-A2	0	27 Mar 2019	4	17 May 2019	7.2	Shoulder immobiliser	After 7 weeks	-	-	-	6	5
13	697256	J	82	F	27 Mar 2019	2 Apr 2019	DF	-	Closed fracture intertrochantric femur left	3 part	11- B1	3	28 Mar 2019	5	-	-	Shoulder immobiliser	After 1 week	-	-	loosening of k-wires	8	5
14	493352	KR	65	F	24 May 2019	26 May 2019	DF	DM-2, Hypertension, Obesity	-	4 part	11- B1	3	25 May 2019	5	16 Jul 2019	7.3	Shoulder immobiliser	After 7 weeks	-	-	-	6	5
15	735987	TS	65	M				Expired															
16	742207	UR	60	F	4 Jun 2019	12 Jun 2019	DF	DM-2, AKI, Hypertension	-	3 part	11-B1	2	6 Jun 2019	6	22 Jul 2019	6.6	Shoulder immobiliser	After 6 weeks	-	-	-	6	5
17	746695	SB	63	F	12 Jun 2019	14 Jun 2019	RTA	-	-	3 part	11-B1	0	12 Jun 2019	7	9 Aug 2019	8.2	Shoulder immobiliser	After 4 weeks	-	-	-	8	5
18	200188	GS	67	M	10 Oct 2019	14 Oct 2019	RTA	DM-2, hypertension, CAD - Post PTCA	Closed Fracture Proximal Tibia left side	4 part	11-B1	0	10 Oct 2019	5	29 Nov 2019	7.1	Shoulder immobiliser	After 7 weeks	-	-	-	7	5

S. NO.	MRD NO.	CONSTANT AND MURLEY SCORE											RANGE OF MOTION (40)												TOTAL SCORE			Results (constant score)
		PAIN (15)		ACTIVITY LEVEL (10)			ARM POSITIONING (10)			Strength of Abduction (pounds) (25)			FORWARD FLEXION			LATERAL ELEVATION			EXTERNAL ROTATION			INTERNAL ROTATION						
		3 MONTHS	6 MONTHS	6 WEEKS	3 MONTHS	6 MONTHS	6 WEEKS	3 MONTHS	6 MONTHS	6 WEEKS	3 MONTHS	6 MONTHS	6 WEEKS	3 MONTHS	6 MONTHS	6 WEEKS	3 MONTHS	6 MONTHS	6 WEEKS	3 MONTHS	6 MONTHS	6 WEEKS	3 MONTHS	6 MONTHS	6 WEEKS	3 MONTHS	6 MONTHS	
1	582755	5	15	2	2	10	2	4	10	0	8	14	0	4	8	0	4	8	2	6	10	0	4	10	6	37	85	Excellent
2	598211	10	10	2	2	10	2	4	6	0	3	7	0	2	6	0	2	6	2	4	8	0	2	6	11	27	59	Fair
3	293755	10	15	2	10	10	4	8	10	0	10	16	0	4	10	0	4	10	2	6	10	0	6	10	18	56	91	Excellent
4	582822	10	15	2	2	10	2	4	6	0	4	7	0	2	4	0	2	4	2	4	4	0	4	8	6	32	58	Fair
5	617969	10	15	2	2	10	2	6	10	0	6	10	0	4	8	0	4	6	2	4	8	0	4	8	11	40	75	Good
6	618082	5	10	2	2	10	2	4	10	0	4	8	0	2	6	0	2	4	2	4	8	0	2	6	11	25	60	Good
7	215505	10	15	2	2	10	2	4	6	0	7	10	0	4	4	0	2	4	2	2	2	0	6	8	11	37	59	Fair
8	631054																											
9	635502																											
10	652178	10	10	6	10	10	2	4	6	0	8	18	0	2	4	0	0	2	2	4	6	0	6	10	15	44	66	Good
11	4144	5	10	2	2	10	2	6	8	0	4	8	0	2	6	0	2	4	2	4	8	0	6	10	6	31	64	Good
12	345275	5	10	2	2	10	2	6	8	0	7	10	0	2	4	0	2	4	0	4	8	0	6	8	9	34	62	Good
13	697256	10	15	2	2	10	2	4	8	0	2	5	0	2	4	0	2	2	2	4	6	0	4	10	11	30	60	Good
14	493352	10	15	2	2	10	4	6	10	0	3	5	0	4	6	0	2	4	2	6	8	0	6	8	13	39	66	Good
15	735987																											
16	742207	10	15	2	2	10	2	4	8	0	4	6	0	4	6	0	2	4	2	4	6	0	4	6	11	34	61	Good
17	746695	10	10	2	2	10	2	4	4	0	4	4	0	0	2	0	0	2	2	4	6	0	4	8	11	28	46	Fair
18	200188	10	15	2	2	10	2	6	8	0	7	10	0	4	6	0	4	6	2	4	8	0	4	8	11	41	71	Good

Baba Farid University
of Health Sciences
Sadiq Road
Faridkot-151 203 (Pb), INDIA.
Phone : 01639-256232,256236
Tele/Fax : 01639-256235
Email – Examination@bfuhs.ac.in

No. BFUHS/2K19p-TH/ 1442 Date 31.5.19

The Principal,
DMC, Ludhiana.

Subject: Approval of Plan of Thesis.

This is to inform you that the Faculty of Medical Sciences in its meeting held on 29.05.2019 has approved the plan of thesis of **Tushar Kant Singla,** a student of your college for **MS Orthopaedics** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis

Functional outcome in patients of fracture proximal humerus managed with k-wire fixation

Supervisor
Dr. Harpal Singh Selhi
Prof.,
Dept. of Orthopaedics,
DMCH, Ludhiana.

Co-Supervisor
Dr. Deepak Jain
Assoc. Prof.,
Dept. of Orthopaedics,
DMCH, Ludhiana.

The student has to submit the four copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

SP Singh
Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

1. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*
2. *The student may submit the thesis as per the schedule already conveyed i.e. for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.*

FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF SURGERY

In

ORTHOPAEDICS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

NOVEMBER, 2018

DR. TUSHAR KANT SINGLA

DEPARTMENT OF ORTHOPAEDICS
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA
LUDHIANA, PUNJAB-141001

ABSTRACT OF PLAN OF THESIS

Title	**FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION**
For the degree of	M.S. Orthopaedics
Name of the candidate	Dr. Tushar Kant Singla
Supervisor	Dr. Harpal Singh Selhi, Professor, Department of Orthopaedics, DMCH, Ludhiana
Co-supervisor	Dr. Deepak Jain, Associate Professor, Department of Orthopaedics, DMCH, Ludhiana
Institution	Dayanand Medical College and Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Proximal humerus fractures, defined as fractures occurring at or proximal to the surgical neck of humerus. Proximal humerus fractures make up 7% of all fractures and 80% of all humeral fractures. These fractures can be managed with both operative and non-operative methods.

Aim of study: This study aims to analyse union time, complications and study the functional outcome of proximal humerus fractures managed with Closed Reduction and K-wire fixation.

Materials and methods: A performa will be filled at the start of the study for retrospective patients from patient charts available in record room and department of Orthopaedics and for prospective patients at the time of admission from 1st January, 2017 to 30th September, 2020.

Clinical significance: Closed reduction and internal fixation with K-wire is associated with minimal soft tissue trauma, leading to better healing and reduced risk of AVN of humeral head

Keywords: Proximal humerus fracture, closed reduction, K-wire fixation.

(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION"** exist in the Department of Orthopaedics at Dayanand Medical College and Hospital, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate himself under our supervision and guidance.

Supervisor

Dr. Harpal Singh Selhi
Professor
Department of Orthopaedics
DMCH, Ludhiana

Co-Supervisor

Dr. Deepak Jain
Associate Professor
Department of Orthopaedics
DMCH, Ludhiana

Head of the Department

Dr. Rajnish Garg
Professor & Head
Department of Orthopaedics
DMCH, Ludhiana

Place: Ludhiana

Date: 21/12/18

APPROVAL PROFORMA
BY
RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	Dr. Tushar Kant Singla
Department	Orthopaedics
Topic of Thesis	FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION
Likely date of appearing in PG examination	MAY 2021
Date of enrollment	MAY 3, 2018
Name of Head of Department	Dr. Rajnish Garg
1) Supervisor **2) Co-Supervisor**	Dr. Harpal Singh Selhi Dr. Deepak Jain
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
1. HOD Pharmacology	1. HOD Physiology
2. HOD Surgery	2. HOD Pathology
3. HOD Pathology	3. HOD Pharmacology
4. HOD Medicine	4. HOD SPM
5. Dean Academics	5. HOD Medicine
6. Vice Principal	6. HOD Surgery
	7. HOD Obst. & Gynae
	8. Legal Expert
	9. Secretary, IEC
	10. Dean Academics
	11. Vice Principal
	12. Principal

Approved: Yes / No

Chairperson
Research Committee

Chairperson
Research Committee

Approved: Yes / ~~No~~

Chairperson
Ethics Committee

Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1	NAME OF THE CANDIDATE AND ADDRESS	DR. TUSHAR KANT SINGLA #56, 16 ACRE SCHEME, NEAR BUS STAND, BARNALA, PUNJAB
2	NAME OF THE INSTITUTE	DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA
3	COURSE OF STUDY AND SUBJECT	M.S. Orthopaedics
4	DATE OF ADMISSION OF COURSE	3rd MAY,2018
5	TITLE OF THE TOPIC	**FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION**

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Proximal humerus fractures, defined as fractures occurring at or proximal to the surgical neck of humerus. The incidence of proximal humerus fracture is rising worldwide. These make up 7% of all fractures and 80% of all humeral fractures. This injury is more common in females than males. The incidence fluctuates with age, and is most common in patients above 50 years of age with average age being 66 years. Elderly females form the largest group of patients sustaining humeral fractures and this is largely attributable to Osteoporosis.[1]

Proximal humerus is made up of four parts - humeral head, greater tuberosity, lesser tuberosity and humeral shaft just proximal to the insertion of pectoralis major tendon.[2] The proximal humerus can fracture as a result of 3 main loading modes:

- compressive loading of glenoid onto the humeral head - in patients with normal bone, humeral epiphysis resists this and the energy is transferred to distally to weaker metaphysial bone leading to surgical neck fracture, whereas in osteoporotic bone epiphysis also fractures, leading to complex multi-fragmentary fractures
- bending forces at surgical neck
- tension forces of rotator cuff at greater and lesser tuberosities - causes displacement of greater tuberosity postero-medially and lesser tuberosity medially

Disruption of normal anatomical relationship between tuberosities, humeral head, and shaft, as well as incongruity of joint can result in decrease in range

of motion and strength of shoulder. Soft tissue scarring and tears of tendons of rotator cuff also contribute to stiffness and loss of movement.[2]

The two most commonly adopted classification system for fracture proximal humerus are Neer's classification (described in 1970) [3] and AO/OTA classification.[1]

The proximal humerus fracture can be managed with both operative and non-operative methods. Closed reduction of the fracture and internal fixation with K-wire is associated with minimal soft tissue trauma, leading to better healing and reduced risk of AVN of humeral head. Two-part, three-part, and valgus-impacted four-part fractures of the proximal humerus can be managed by this technique. The surgeon is required to have a thorough understanding of the radiographic morphology of the proximal humerus and a detailed understanding of the structures at risk of iatrogenic injury - including cephalic vein, long head biceps, axillary nerve etc.[3]

6.2 REVIEW OF LITERATURE

Rowles et al [4] pinned ten fresh-frozen cadaveric shoulders with the intact proximal part of the humerus under fluoroscopic guidance. A total of five 2.5-mm terminally threaded AO pins, including two lateral, one anterior, and two greater tuberosity pins, were used in each shoulder. The specimens were then dissected to determine the distance of each pin from adjacent neurovascular structures as well as key anatomic relationships. The proximal lateral pins were located at a mean distance of 3 mm from the anterior branch of the axillary nerve. Four of the twenty lateral pins were noted to penetrate the articular cartilage of the humeral head. The anterior pins were located at a mean distance of 2 mm from the tendon of the long head of the biceps (perforating the tendon in three specimens) and of 11 mm from the cephalic vein (perforating the vein in one specimen). The proximal tuberosity pins were located at a mean distance of 6 and 7 mm from the axillary nerve and the posterior humeral circumflex artery (tenting the structures in two specimens with internal rotation), respectively. These pins moved away from the nerve with external rotation of the humerus. The study concluded that this technique may be associated with a risk of injury to important anatomic structures about the shoulder. Lateral pins should be distal enough to avoid injury to the anterior branch of the axillary nerve, and multiple fluoroscopic views should be obtained to avoid penetration of the humeral head cartilage. There may be a risk of injury to the cephalic vein, the biceps tendon, and the musculocutaneous nerve with use of anterior pins, and these pins should be employed with caution. Greater tuberosity pins should be placed with the arm

in external rotation, should be aimed for a point 20 mm from the inferior aspect of the humeral head, and should not overpenetrate the cortex.

Resch et al [5] studied 27 patients, 9 with 3-part and 18 with 4-part fractures, treated by percutaneous reduction and screw fixation. Thirteen of the 4-part fractures were of the valgus type and five showed significant shift. Instruments were introduced into the fracture through small incisions to manoeuvre fracture fragments under the control of an image intensifier. The average follow-up was 24 months (18 to 47). All the 3-part fractures showed good to very good functional results, with an average Constant score of 91% (84% to 100%), and no signs of avascular necrosis. Good radiological results were achieved in 4-part fractures when impacted in valgus except for one patient with partial avascular necrosis of the head. In those with lateral displacement of the head, revision to a prosthesis was required in one patient because of avascular necrosis and in another because of secondary redisplacement of the fracture. Avascular necrosis was seen in 11% of 4-part fractures. The average Constant score in patients with 4-part fractures who did not need further operation was 87% (75% to 100%).

Keener et al [6] studied the outcomes of displaced proximal humeral fractures after closed or percutaneous reduction with percutaneous fixation. This study included 35 patients of which, 27 were followed up for a minimum of 1 year after surgery. There were seven 2-part, eight 3-part, and twelve valgus-impacted 4-part proximal humeral fractures. All fractures were reduced and stabilized with percutaneous techniques only. The mean duration of follow-up was 35 months. All fractures healed after the index procedure. The mean pain score on a visual analog scale was 1.4. The mean American Shoulder and

Elbow Surgeons and Constant scores were 83.4 and 73.9, respectively. Four patients healed with malunion, and in four, glenohumeral joint osteoarthritis developed. Fracture type, age, malunion, or osteoarthritis had no significance influence on measured outcomes. This study concludes that the percutaneous treatment of selected proximal humeral fractures results in predictable union and good clinical results with a low rate of complications.

Bahrs et al [7] conducted a retrospective study to evaluate displaced proximal humeral fractures treated with a non plate head-preserving fixation and to detect factors predicting functional outcome. After a median follow-up period of 79.7 months, 105 patients with 9 A-fractures, 36 B fractures and 60 C-fractures (nine two-part-fractures, 41 three-part fractures and 55 four-part fractures) were assessed. Functional outcome was measured based on the Constant and UCLA scores. Of all patients, 70–75% had excellent or good Constant and UCLA scores. In 74% a good or satisfactory quality of initial reduction fracture was achieved. About one-fifth (21%) of the fractures showed a secondary displacement. Twenty-seven percent of the patients had signs of humeral head necrosis and 22% had implant related problems. There were significant correlations between a high final score and young age, low AO fracture severity, good quality of fracture reduction and residual osseous deformity, absence of secondary fracture displacement, implant-related complications, shoulder arthrosis and humeral head necrosis at the time of follow-up. In conclusion, the non-plate head-preserving fixation of proximal humeral fractures is an alternative treatment for displaced proximal humeral fractures.

Bogner et al [8] studied 76 patients aged over 70 years with three- or four-part fractures treated by percutaneous reduction and internal fixation using the Humerusblock. Of the patients 50 (51 fractures) were available for follow-up after a mean of 33.8 months (5.8 to 81). The absolute, age-related and side-related Constant scores were recorded. Of the 51 fractures, 46 (90.2%) healed primarily. Re-displacement of fragments or migration of K-wires was seen in 5 cases. Necrosis of the humeral head developed in 4 patients. In 3 patients a secondary arthroplasty had to be performed, in 2 because of re-displacement and in 1 for necrosis of the head. The mean Constant score of the patients with a three-part fracture was 61.2 points (35 to 87) which was 84.9% of the score for the non-injured arm. In four-part fractures it was 49.5 points (18 to 87) or 68.5% of the score for the non-injured arm. The study concluded that Humerusblock technique can provide a comfortable and mobile shoulder in elderly patients and is a satisfactory alternative to replacement and traditional techniques of internal fixation.

Drader et al [9] studied 35 patients with four-part displaced proximal humeral fractures and fracture-dislocations were retrospectively reviewed from the years 1977-1990. Thirty-three patients were available for study. All fractures were treated by open reduction and internal fixation allowing early motion. Surgical technique was as atraumatic as possible with the goal of restoring normal anatomy of the proximal humerus with a minimal fixation system. The fixation device consisted of two modified Kirschner wires introduced through the tuberosities and reinforced by a tension band wiring. Neer's criteria were used to evaluate results. With a mean follow-up of 7 years, results were excellent and satisfactory in 21 cases, non satisfactory in 10, and poor in two.

The most common complication was avascular necrosis (nine patients). This study concluded that in four-part displaced fractures, open reduction and internal fixation with our system of osteosynthesis should be indicated initially and prosthetic replacement should be considered as primary treatment in cases with marked comminution of the humeral head, in fracture-dislocations, and in patients > 75 years of age

Carbone et al [10] evaluated the results of percutaneous fixation of three- or four-part fractures of the proximal humerus of patients. A total of 31 patients treated with MIROS and 27 undergoing traditional percutaneous pinning (TPP) were enrolled in the study. Pre-operatively anteroposterior and transthoracic or axillary radiographs were obtained in all cases and CT scans in patients with the most complex fractures. Follow-up evaluations were carried out at three, six, 12 and 16 weeks, and six months, one year and two years postoperatively, using the Constant Score (CS) and subjective shoulder value (SSV) methods. Of the 58 patients, 52 could be evaluated at all follow-ups. In both three- or four-part fractures there were significantly higher CS and SSV scores in the MIROS compared to the TPP group at all the late follow-ups. Lower rates of deep infection, pin tract infection and pin mobilisation were found in the MIROS group ($p < 0.001$). In both groups there was a significant association between the final result (CS) and either the type of fracture or complications ($p < 0.001$).The study concluded that MIROS resulted in better clinical results and less complication than TPP in elderly patients.

El-affy et al [11] studied 18 patients with displaced proximal humeral fractures were treated by closed reduction and percutaneous fixation with the palm tree

technique after minor modifications. The age of the patients ranged from 38 to 75 years with an average of 56 years. The fractures were two-part in 13 cases and three-part fractures in five cases. The average time of healing was seven weeks. The follow-up period ranged from 14 months to 39 months. The Constant score ranged from 45 to 88 with a mean of 73. The results were satisfactory in 77% and unsatisfactory in 23% of the cases. The complications included pin tract infection in 2 cases, intraarticular wire migration in 1 case, skin necrosis around the wires in 3 cases and malunion with varus deformity in 1 case. It was concluded that palm tree technique produces good grip in both of the proximal and distal fragments and allows for early joint movements.

Blonna et al [12] compared a new technique called hybrid technique (HT), that used osteosutures and an external fixator, with traditional pins fixation. 51 patients were treated with percutaneous fixation using 2.5-mm terminally threaded pins and 55 patients were treated with the Hybrid technique. In both groups, an open reduction and osteosutures augmented with percutaneous fixation was used when closed reduction was insufficient to provide anatomical reduction. The patients were assessed at 6- and 12-month follows-ups using DASH score, Constant score, and Modified Constant score (MCS). Sixteen patients treated with traditional pins experienced complications compared to 6 patients in the HT group. Pins migration affected 8 patients in the traditional pins group and 1 case in the hybrid group. The MCS at the 12-month follow-up was 89 □ 9 in the HT group and 77 □ 14 in the traditional pins group. It was concluded that the HT is a valuable option for the treatment of proximal humeral fractures with potential benefits

Blonna et al [13] retrospectively studied the outcome of K-wire osteosynthesis of a varus displaced proximal humeral fracture in patients over 65 years old, compared to a control group treated nonoperatively, using the Constant score (CS), modified Constant score (MCS), and the Quick DASH score. The patients were followed-up for 12 months. It was concluded that K-wire osteosynthesis of varus displaced proximal humerus fractures yielded good results that are superior to those treated nonoperatively.

Foruria et al [14] prospectively studied the effect of the initial pattern of fracture and the displacement of fragments on the outcome of proximal humeral fractures treated conservatively in 93 patients followed for one year. Final movement and strength were compared with those of the contralateral side using the American Shoulder and Elbow Society score and the Disabilities of Arm, Shoulder and Hand and Short-Form 36 questionnaires. Radiographs and CT scans with three-dimensional reconstruction were obtained in all patients. The pattern of the fracture and the displacement of individual fragments were analysed and correlated with the final outcome. There were two cases of nonunion and six of avascular necrosis. The majority of the fractures (84 patients; 90%) followed one of the following four patterns: posteromedial (varus) impaction in 50 patients (54%), lateral (valgus) impaction in 13 (14%), isolated greater tuberosity in 15 (16%), and anteromedial impaction fracture in six (6%). Head orientation, impaction of the surgical neck and displacement of the tuberosity correlated strongly with the outcome. In fractures with posteromedial impaction, a poor outcome was noted as the articular surface displaced inferiorly increasing its distance from the acromion. A poorer outcome was noted as a fractured greater tuberosity

displaced medially overlapping with the posterior articular surface. Lateral impaction fractures had a worse outcome than other patterns of fracture.

6.3 AIMS AND OBJECTIVES OF THE STUDY

To analyse union time, complications and study the functional outcome of proximal humerus fractures managed with Closed Reduction and K-wire fixation.

7.0 MATERIAL AND METHODS

This study is a prospective study of patients with proximal humerus fractures treated with Closed Reduction and K-wire fixation. The patients operated at Dayanand Medical College and Hospital, Ludhiana from 1st November, 2018 to 31st December, 2019 will be included in this study

1. SOURCE OF DATA

A performa will be filled at the start of the study for prospective patients at the time of admission.

2. METHOD OF COLLECTION OF DATA

Inclusion criteria:

1. Closed Proximal Humerus fractures

Exclusion criteria:

1. Fracture dislocation of Head of Humerus
2. Humeral Head splitting fracture
3. Infection at the site of fracture
4. Patients below 18 years of age
5. Pathological fractures
6. Fractures dislocations more than 4 weeks old

Patient coming to Emergency department will be evaluated for any life threatening injury and general condition of the patient will be assessed and affected limb will be splinted. All routine investigations will be sent as per protocol. Appropriate radiographs will be taken to assess the fracture. Classification of fracture will be done using Neer's classification system and AO/OTA classification system. Patients will be taken up for orthopaedic surgery after obtaining pre-anaesthetic clearance.

Surgical Technique - Patient will be positioned on radiolucent OT table in supine or 'beach chair' or semi beach chair position depending upon the surgeon preference with a pack holding the shoulder and thorax about 30-40 degrees off the table. Required parts painted and draped as per antiseptic protocol. Adequate visualisation of the fracture will be done under fluoroscopy. Reduction manoeuvres will be performed. Major landmarks will be surface marked on skin to avoid potential injury. Closed reduction of surgical neck fracture component will be performed. K-wire will be inserted in proximal humerus depending on the fracture anatomy. Reduction and fixation will be confirmed under fluoroscopy. K-wires will be cut to appropriate length. Skin closure will be done in layers. Joint will be immobilised with the help of shoulder immobiliser.

Follow up will be done at 7 or 14 days, then at 1 month, and then every month. Patient will be assessed clinically for fracture healing, range of motion, K-wire wounds and will be radiographically checked for the progress of fracture healing. Radiographic union will be defined as bridging trabeculations across the fracture site in the absence of hardware breakage or cut-out.

Constant and Murley score - This method of shoulder functional assessment combines patient as well as clinician based score. It consists of 100 points allotted to following parameters - Pain (15), Activities of daily living (20), Range of motion (40), and Power (25).[15] Functional assessment will be done at 6 weeks, 3 months and 6 months of follow up in prospective patients. The score at 6 months will be taken as final functional outcome in all patients.

Duration of study: The patients operated at Dayanand Medical College and Hospital, Ludhiana from 1st November, 2018 to 31st December, 2019 will be included in this study.

Outcome: This study will analyse union time, complications and functional outcome of proximal humerus fractures managed with Closed Reduction and K-wire fixation

STATISTICAL ANALYSIS:

Data will be described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. All statistical calculations will be done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEF?

This study requires surgical intervention in patients with closed fracture proximal humerus.

7.4 HAS ETHICAL CLEARANCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Attached along with.

8. LIST OF REFERENCES

1. Court-Brown CM, Garg A, McQueen MM. The epidemiology of proximal humeral fractures. Acta Orthop Scand. 2001;72:365-71.
2. Streubel PN, Sanchez-Sotelo J, Steinmann SP. Proximal Humeral Fractures. In: Court-Brown CM, Heckman JD, McQueen MM, Ricci WM, Tornetta P III (editors). Fractures in adults; 8th edition. Lippincott Williams & Wilkins: Philadelphia, USA; 2015. p. 1341-427.
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PROFORMA

NAME :

AGE/SEX :

MRD NO. :

ADMISSION NO.:

DATE OF ADMISSION :

DATE OF DISCHARGE :

Mode of injury

- Road traffic accident
- Domestic fall
- Others -

_____

Associated illness

_____

_____

_____

_____

Details of fracture -

_____

_____

X-rays

Signature of Candidate

Signature of Supervisor

Pre-operative Antibiotic Prophylaxis -

Time lag between Injury and Surgery -

Date of Surgery -

No. of K-wires used -

Date of K-wire removal -

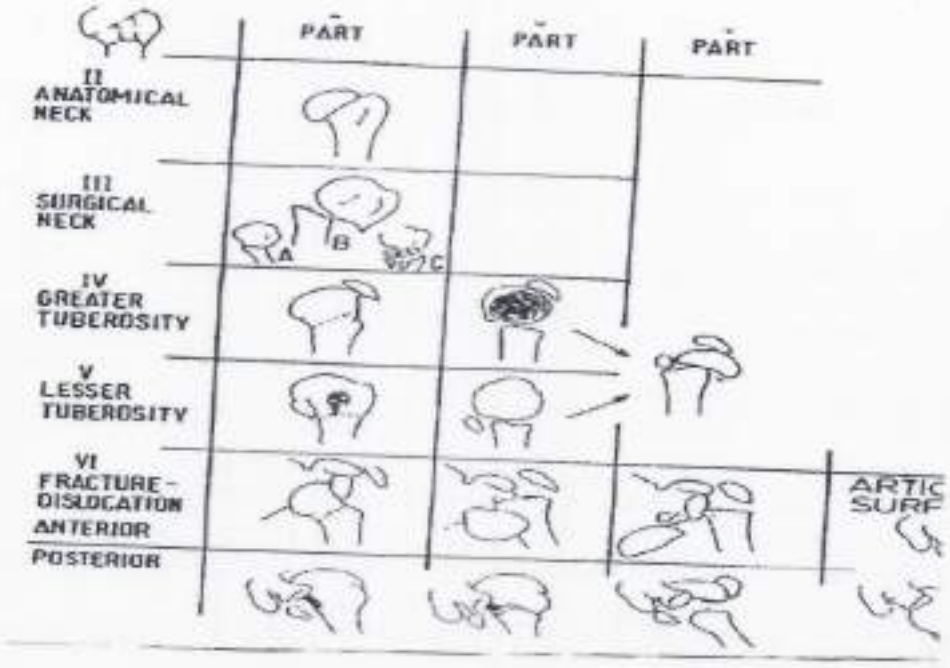
Remarks :

Immobilisation done with -

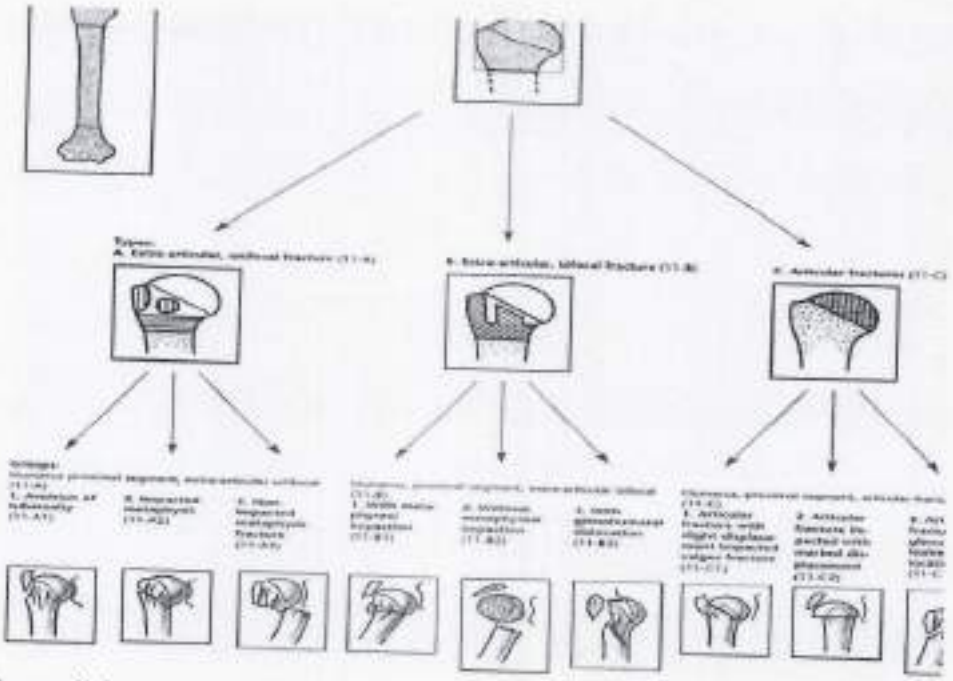
Physiotherapy details Started on ___ Post op day

Signature of candidate **Signature of Supervisor**

NEER'S Classification



AO/OTA Classification



Signature of candidate

Signature of Supervisor

Complication details

1. Intra-op Complication
    1. Nerve Palsy
    2. Vascular injury
    3. Loss of reduction
    4. Any other
2. Immediate Post-op Complications
    5. Wound infection - Superficial / Deep
    6. Post-op Bleeding
    7. Loss of reduction
    8. Any other
3. Late Post-op Complications
    - Non-Union
    - Malunion
    - Avascular necrosis of humeral head
    - Pin site infection
    - Loosening of K-wires
    - Breakage of K-wires
    - Shoulder stiffness
    - Migration of K-wires

Signature of candidate **Signature of Supervisor**

- Any other

Radiological Findings on follow up

4 weeks

_____

_____

8 weeks

_____

_____

12 weeks

_____

_____

6 months

_____

_____

Union time

Clinical _____ Radiological _____

Signature of candidate **Signature of Supervisor**

Constant and Murley score

	6 weeks	3 months	6 months
1. Pain (15)			
Severe (0)			
Moderate (5)			
Mild (10)			
None (15)			
2. Activity Level (10)			
Unaffected sleep (2)			
Full recreation / sport (4)			
Full work (4)			
3. Arm Positioning (10)			
Up to Waist (2)			
Up to Xiphoid (4)			
Up to Neck (6)			
Up to Top of Head (8)			
Above Head (10)			
4. Strength of Abduction [Pounds] (25)			

*1 point for every pound lifted

Signature of candidate **Signature of Supervisor**

RANGE OF MOTION (40)

5. **Forward Flexion**

0-30 degrees (0)			
31-60 degrees (2)			
61-90 degrees (4)			
91-120 degrees (6)			
121-150 degrees (8)			
151-180 degrees (10)			

6. **Lateral Elevation**

0-30 degrees (0)			
31-60 degrees (2)			
61-90 degrees (4)			
91-120 degrees (6)			
121-150 degrees (8)			
151-180 degrees (10)			

7. **External Rotation**

Hand behind Head, Elbow forward (2)			
Hand behind Head, Elbow back (2)			
Hand to top of Head, Elbow forward (2)			

Signature of candidate **Signature of Supervisor**

Hand to top of Head, Elbow back (2)	_____	_____	_____
Full Elevation (2)	_____	_____	_____
8. **Internal Rotation**			
Lateral Thigh (0)	_____	_____	_____
Buttock (2)	_____	_____	_____
Lumbosacral Junction (4)	_____	_____	_____
Waist (L3) (6)	_____	_____	_____
T12 Vertebra (8)	_____	_____	_____
Interscapular (T7) (10)	_____	_____	_____

REMARKS

Signature of candidate

Signature of Supervisor

INFORMED PATIENT CONSENT

Date: _____

I.....D/o, W/o, S/o..... .....am willing to participate in the study "**FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

....

Signature of the Witness Signature of the patient

Name:

Signature of Candidate **Signature of Supervisor**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____

निवासी _____

इस शोधकार्य "**FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION**" में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

"FUNCTIONAL OUTCOME IN PATIENTS OF FRACTURE PROXIMAL HUMERUS MANAGED WITH K-WIRE FIXATION" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____ _____

ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

_____

ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____

ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ